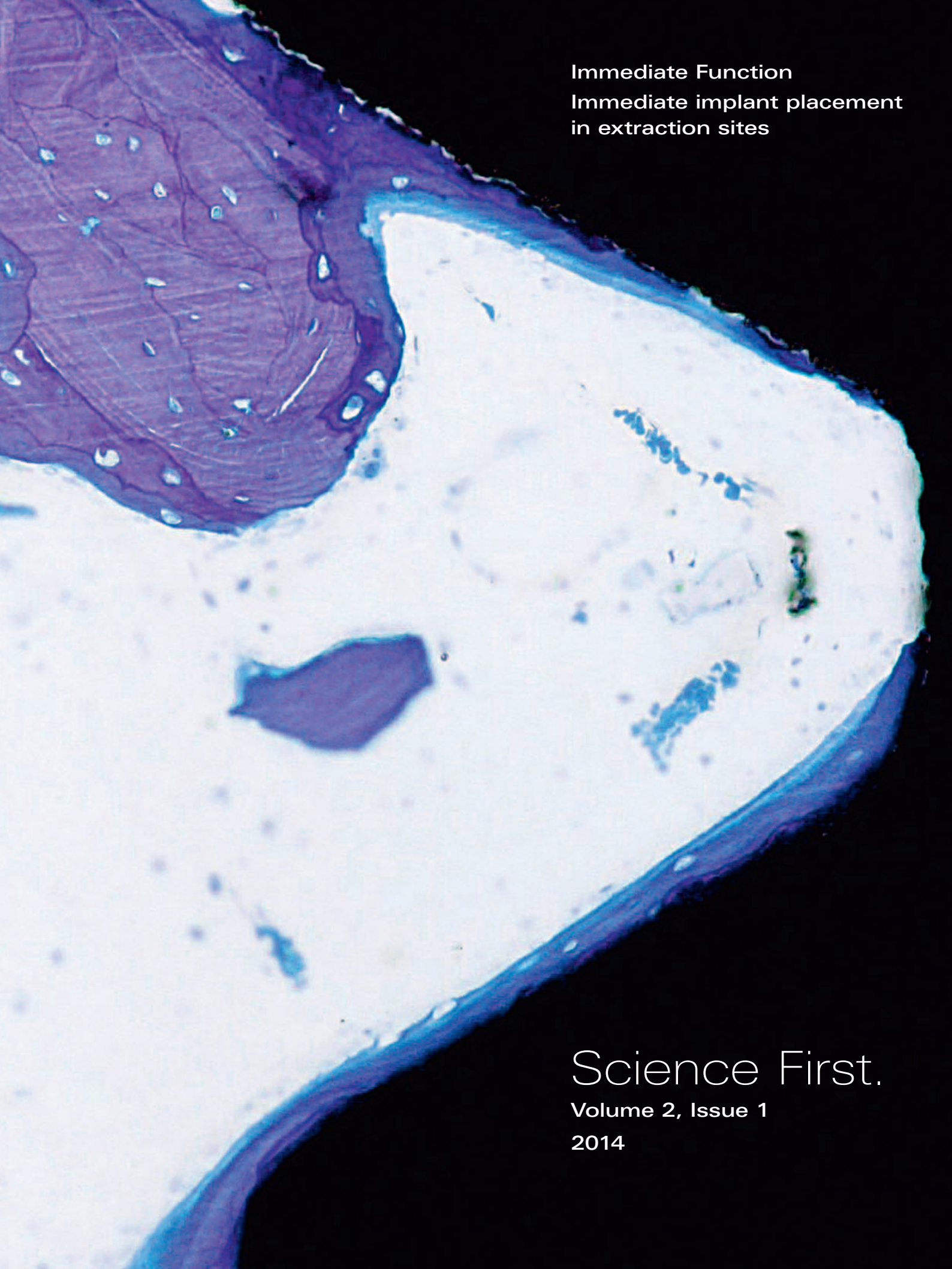

Immediate Function

Immediate implant placement in extraction sites

Science First.

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Cover picture: Light microscopic image showing the bone formation pattern along the TiUnite surface after three weeks of healing. The bone grows in direct contact with the implant surface along the contours of the threads, indicating that TiUnite is osteoconductive (courtesy of Dr. Peter Schüpbach, Switzerland).

Contents.

In the best interest of your patients.

During 2012, and again in 2013, Nobel Biocare significantly increased its investments in Research and Development (R&D). Today, our R&D funding, as a percentage of sales, is above 11%, which represents the highest level of investment among major companies in our industry.

This investment has a clear purpose. It allows you, and all our other valued customers, to confidently treat more patients better with our superior products and treatment solutions. A significant portion of our R&D investment goes to funding the clinical research and technical documentation that demonstrates that our products and solutions are safe, effective and predictable – and in the long-term best interests of your patients.

In this issue of Science First, we address two important treatment methods: Immediate Function, and immediate implant placement in extraction sites. Both concepts have the potential to shorten healing times, reduce the number of appointments and costs, and improve clinical outcomes. In short, they can result in much higher patient satisfaction. However, only a relatively small number of clinicians have been using these treatment methods up to now. They are advanced treatment procedures requiring proper planning, patient selection, and training. To meet this need, Nobel Biocare offers training and education on Immediate Function and immediate placement in extraction sites in its advanced surgical and prosthetic procedures curriculum.

We trust the evidence presented in this issue of Science First will provide you with an understanding that Immediate Function and immediate implant placement in extraction sites can increase patient satisfaction without compromising on implant survival or soft and hard tissue health. We hope it gives you the information you need to consider these treatment modalities for your own practice where appropriate, providing you with more options for treating your patients in line with their best interests, and to the highest professional standard.

«Treat more patients better – thanks to our superior products and treatment solutions, as well as our comprehensive training opportunities that help you choose the right solution for your patients.»

Richard Laube, CEO Nobel Biocare

The importance of correct comparisons.

Historically, implant loading several months after surgery was considered to be a prerequisite for successful osseointegration. However, the introduction of more advanced implant designs and surfaces has made immediate loading an increasingly applied and reliable treatment option. It can be performed with all Nobel Biocare implants with TiUnite surface. Scientific evidence demonstrates that it works.

Not all definitions of immediate are the same

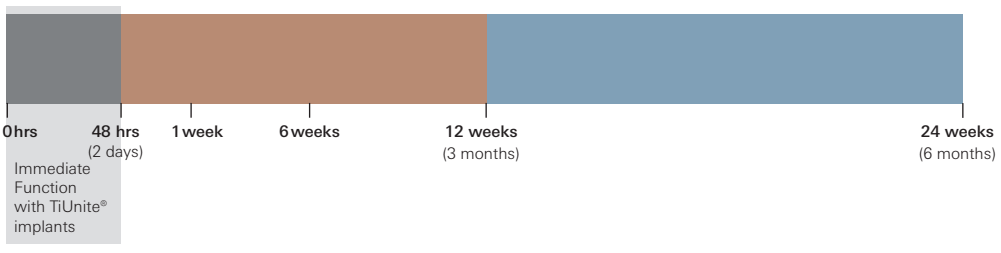
What is meant by "immediate", "early" and "delayed" loading? To draw any conclusions regarding its impact on clinical outcomes, it is important to check not only which loading protocol was applied, but also how the authors of the study defined it. For example, immediate may refer to implant loading within a few days,[1] one week[2] or even two weeks.[3] The range for early loading varies even more: from two weeks to three months after implant placement.[2,3,4] "Delayed" refers to several weeks or several months of healing prior to imposing occlusal loads.[2,3,4]

A pivotal event advancing consensus on definitions of loading was the 2002 Sociedad Española de Implantes World Congress consensus meeting held in Barcelona (Spain) from which the accepted definitions evolved (see figure).[4] The term Immediate Function started to appear in the implant dentistry literature in the early 90s.[5] It was since adopted by Nobel Biocare to describe its immediate loading treatment concept with esthetic and partly functioning teeth directly (≤48 hours) after implant insertion.

Too many variables prevent reliable conclusions

In the recently updated Cochrane Review, Esposito et al. (2013) conclude that varying loading times do not have any statistically significant influence on survival rates of implants and prostheses, both at patient and implant level, which may be due to the low failure rates reported in all available randomized trials.[3] Maintenance of marginal bone level, on the other hand, may favor immediate loading: 15 randomized controlled trials showed a statistically significant mean difference of 0.1 mm, which was however deemed clinically irrelevant.[3]

Although meta-analysis is statistically the most powerful tool we have available, such reviews cannot be used to favor any particular loading protocol for all patients and all clinical indications due to the heterogenity of the included studies. They collect and normalize data from studies with a high diversity of clinical protocols, implant types (geometries and surfaces) and prosthetic superstructures, rendering any clinical conclusions weak.



Varying definitions of loading protocols
At Nobel Biocare, Immediate Function means that patients have esthetic and partly functioning teeth in place directly (≤48 hours) after implant insertion.

High implant stability allows for Immediate Function.

Implants with TiUnite surface are designed for high primary stability and are CE marked in the European Union and cleared by the U.S. Food and Drug Administration (FDA) for Immediate Function. Immediate Function offers a valid alternative to the two-stage protocol originally developed by Professor Per-Ingvar Brånemark over three decades ago. It has the potential to shorten healing times, reduce the number of appointments and costs, increase patient satisfaction and improve clinical outcomes. It is highly successful with a tapered implant geometry such as NobelActive and NobelReplace Tapered, the TiUnite surface, non-occlusal contact and control of chewing forces during the first months.[6]

Pioneering studies with machined Brånemark System implants

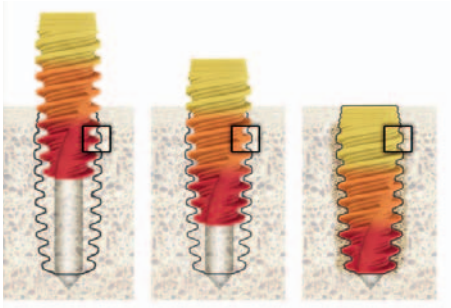
Delayed implant loading was once considered a prerequisite for successful osseointegration. Already in the late eighties and early nineties, however, clinicians such as Balshi and Schnitman separately explored immediate loading as a treatment alternative with machined implants.[7,8] Schnitman et al. (1990) established proof of concept of Immediate Function with Brånemark System implants. Abutments were connected to three test implants and a fixed bridge converted from the patient's denture was immediately loaded, while 4 to 5 remaining implants were left to heal.[8] Today, immediate loading has become an evidence-based and predictable treatment alternative, as good results were more consistently achieved with the introduction of the surface TiUnite. This moderately rough surface has demonstrated superiority in the Immediate Function protocol in the majority of comparative studies (see table on page 26).

Five important prerequisites for the Immediate Function method

Prerequisite 1 – high primary stability

In a Cochrane Review, Esposito et al. (2007, updated 2013) reveal that a high initial implant stability, which the authors associate with an insertion torque of at least 35 Ncm, is crucial for a successful treatment outcome with immediate loading.[2,3] Implant and thread geometries as well as drilling protocol therefore play an important role. NobelActive, for example, is a tapered implant following a straight drilling protocol with widely spaced double-lead threads that compress bone gradually during insertion. This results in an exceptionally high primary stability with maximum torque forces of up to 70 Ncm, allowing for Immediate Function even under demanding conditions such as fresh extraction sites and osteoporotic bone.[9,10,11]

The right combination between implant design and drilling protocol ensures high initial stability also in soft bone



NobelActive's sharp apex with drilling blades allows for smaller osteotomies and therefore preserves as much bone as possible.

NobelActive's tapered implant body acts like consecutive osteotomes, compressing bone gradually during insertion.

Prerequisite 2 – maintenance of high stability

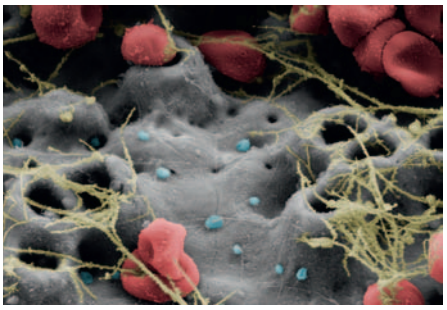
The introduction of TiUnite has accelerated the shift from delayed to early and immediate loading. TiUnite is a moderately rough surface (S_a range of 1.0–1.2µm) that ensures high osteoconductivity and fast anchorage of newly formed bone. It therefore maintains the stability achieved at implant insertion throughout the critical healing phase. Most published clinical studies on TiUnite implants report very high survival rates independent of applied loading and any reported survival differences are neither statistically significant nor clinically relevant.

Studies comparing TiUnite and machined implants in Immediate Function prove the advantage of TiUnite (see table on page 26). Implants with TiUnite surface are known to achieve faster secondary stability than implants with a machined surface.[12,13] This supports better outcomes with immediate loading. In a long-term randomized study with 9-year follow-up, Rocci et al. (2013) show that TiUnite implants achieve a significantly higher cumulative survival rate (CSR) than machined implants (95.5% vs 85.5%).[14]

The importance of primary stability is underscored in the following prospective study with immediately loaded machined implants. Calandriello et al. (2003) report a high 98% CSR of implants immediately loaded with fixed temporary partial bridges in light occlusion. By underpreparing the osteotomy, they achieved a high insertion torque of 40 Ncm for all surviving implants, while the lost implant had an insertion torque of only 15 Ncm.[15]

Prerequisite 3 – controlled occlusal forces

The following study shows that the high survival rates of superior TiUnite implants can also be achieved with machined implants if occlusal forces are properly controlled. By avoiding occlusal contact with antagonist teeth, Malo et al. (2000) were able to achieve a CSR of 96% at 6 months to 4 years of follow-up with immediately loaded Brånemark System Mk II implants.[16] They evaluated 94 implants supporting 54 fixed prostheses in 49 consecutive patients, all placed in the esthetic zone. In another study, Kielbassa et al. (2009) evaluated 325 TiUnite implants (199 NobelActive, 126 NobelReplace Tapered) in 177 partially edentulous patients using an Immediate Function protocol.[17] The majority were placed in the posterior mandible and therefore were subject to high chewing forces. The cumulative survival rate of implants was above 96% at both this 1-year and a later 3-year follow-up, reported by Arnhart et al. (2012).[17,6] However, whenever possible the occlusal contact should be reduced for the first two to three months after implant placement.



Platelets attraction: The negatively charged TiUnite surface attracts blood proteins and inactive platelets (blue) immediately after implant insertion. Simultaneously, fibrils of the fibrin meshwork (yellow) become visible.

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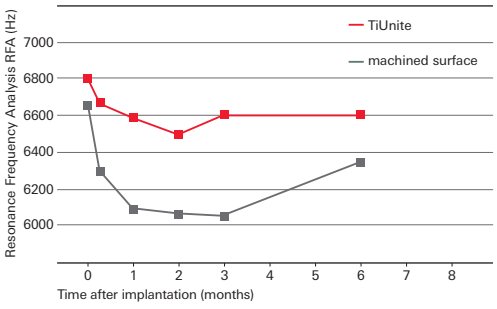
High stability in the critical healing phase allows for Immediate Function



Higher stability with immediately loaded TiUnite surface implants than with the same implants with machined surface in the posterior maxilla.[12]

Prerequisite 4 – careful patient selection

The challenge of abandoning a delayed loading protocol in favor of immediate loading lies in the imposing forces on the endosseous implants. If uncontrolled, these forces may lead to significant movements during the healing phase, resulting in fibrous encapsulation of the implant rather than successful osseointegration with intimate bone-to-implant contact.[18]

When considering Immediate Function, the following factors therefore need to be assessed:

– Jaw location and chewing forces, which in the anterior are a fraction of those experienced in molar areas.
– Degree of edentulism and presence of any nearby teeth.
– Prosthetic parameters such as rigidity of the prosthetic restoration, occlusal surface area, and cantilevers.
– Presence of parafunctions such as bruxism.
– Patient's overall health status including co-morbidities and bone quality.
– Ability to follow nutritional instructions (e.g. to avoid "tearing" forces and hard food).

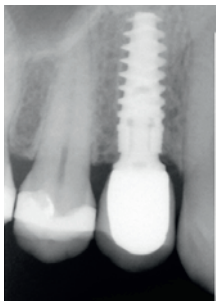
It is important to listen carefully to the patient's wishes. In oral implant placement, the faster improvement in quality of life as well as cost- and time-saving aspects may be decisive arguments for faster function of the inserted implants. However, clinicians need to determine which loading protocol is the most appropriate for each individual patient. The decision for immediate loading should be based on individual patient needs, risk-benefit analysis and sufficient scientific evidence for a reliable outcome.

Prerequisite 5 – clinician's experience

Clinical studies are mainly run by highly experienced clinicians. Since immediate loading can be a protocol requiring advanced clinical skills, the clinician's experience is a relevant factor in achieving the good results found in most studies. Training on the Immediate Function protocol is required and it is widely available through many universities, independent practices and commercial organizations around the world.

Excellent clinical results

Implant at insertion



5-year follow-up

5-year follow-up

Careful patient-specific treatment selection leads to excellent results even under demanding conditions such as Immediate Function in extraction sites. The implant used in this case is NobelActive.

Courtesy of Dr. Louwrens C. Swart, South Africa

Reliable long-term results.

Clinical studies with up to 11 years of follow-up confirm the reliable performance of implants with TiUnite surface – frequently following the Immediate Function protocol. Immediate Function has been clinically documented with more than 21,500 Nobel Biocare implants with TiUnite or machined surfaces in over 6000 patients in various indications.

Key findings of the clinical studies on Immediate Function with TiUnite implants are:
– Immediate Function is a proven long-term solution with cumulative survival rates (CSR) of 97.6% at 10 years[19] and 97.1% at 11 years.[20]
– High CSR of 95%–100% across all studies with follow-up times of at least 5 years (see figure).
– No significant difference between immediate and delayed loading reported by any study (see table on page 24).
– A 10% higher success and survival rate with immediately loaded TiUnite implants compared to machined implants after 9 years of loading.[14]
– Stable bone levels[28,29] with good pink esthetics and papilla score outcomes.[29,30]

Good clinical results are not a given

Despite this body of supporting data, good results cannot be taken for granted. For example, technical complications, including misfits between abutment and titanium cylinder, extensive occlusal adjustments and screw loosening accompanied a lower CSR rate of 90% at 1-year follow-up by Landázuri-Del Barrio et al. (2013).[31] Sanna et al. (2007) report low overall CSR, but 8 out of 9 failed implants were in 3 smoking patients, resulting in a CSR of 81.2% for the smoking group, while non-smokers had an implant CSR of 98.9% at up to 5 years.[32] Smoking also had a negative effect on marginal bone levels: -2.6 mm compared with -1.2 mm in the non-smoking group. These two studies underline the fact that a variety of factors can lead to different outcomes.

Long-term studies show consistently high CSR

Study	Follow-up	CSR
Glauser 2012[20]	11 years	97.1%
Degidi et al. 2012[19]	10 years	97.6%
George 2011[21]	9 years	99.0%
Migliorança et al. 2012[22]	8 years	96.5%
Noelken et al. 2012[23]	5 years	96.8%
Calandriello et al. 2011[24]	5 years	95.0%
Jokstad 2013[25]	5 years	96.4%
Malo et al. 2012[26]	5 years	98.0%
Mura 2012[27]	5 years	100%

Studies with follow-up times of at least 5 years show high cumulative survival rates (CSR) of TiUnite implants in Immediate Function.

Healthy hard and soft tissues.

Immediate Function preserves hard and soft tissue health

In the updated Cochrane Review, Esposito et al. (2013) conclude that immediately loaded implants show a slightly better marginal bone maintenance (0.1 mm) than conventionally loaded implants.[3] Although this slight difference is deemed not clinically relevant, it was statistically significant and it puts to rest any concern that an unloaded healing period may be necessary. Two studies included in the review that evaluated NobelReplace Tapered implants, Den Hartog et al. (2011) and Meloni et al (2012), show no significant difference in bone level change.[29,28] A third also with TiUnite implants, Schincaglia et al. (2008), shows a statistically significant lower 0.5 mm bone level change with immediate compared to delayed loading of 30 Brånemark System implants for replacement of single mandibular molars.[33]

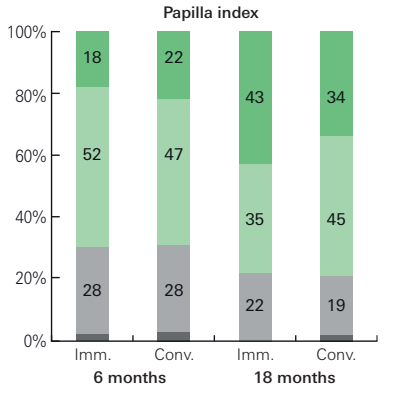
Vasak et al. (2012) in their three-center study on NobelReplace Tapered even report significantly less marginal bone remodeling with immediate (-0.78 mm) than with delayed loading (-2.15 mm) after one year (P=0.005).[34] They evaluated 30 patients with partially or completely edentulous jaws that were treated with the guided surgery concept NobelGuide. However, some bias may result from the fact that Immediate Function protocols were performed in two of the three centers, while the third performed all of the delayed loading procedures.

Most studies also report no impact of loading protocol on soft tissue analyses, including periodontal probing depth and bleeding on probing. Den Hartog et al. (2011) also evaluated pink esthetics, papilla index and height of keratinized tissue, all with no significant differences.[29] This confirms the safety of Immediate Function in terms of soft tissue health.

Immediate Function in extraction sites

There is growing evidence that immediate loading of implants inserted into fresh extraction sites leads to more favorable soft tissue levels compared with delayed loading. De Rouck et al. (2009) show that immediate stabilization of the soft tissue after tooth removal by means of Immediate Function results in a mean 0.75 mm more soft tissue preservation midfacially (midfacial recession is 2.5–3 times higher with conventional loading [P=0.005]).[30] Furthermore, patients with delayed loading take a full additional year to regain papilla height compared with immediate loading.[30]

No impact of loading protocol on soft tissue analyses



Imm. = immediate loading; Conv. = conventional loading

score 0, no papilla

score 1, less than half of the papilla

score 2, at least half of the papilla

score 3, papilla fills up entire proximal space

For single implants in the anterior maxilla, Den Hartog et al. (2011) conclude that immediate non-occlusal loading is not less favorable than conventional loading with regards to marginal bone level change, soft tissue aspects (probing depth, plaque, bleeding, soft tissue level) and esthetics.[21]

From single-tooth to full-arch restorations.

Good results in both jaws and in compromised bone

The longest follow-up available for TiUnite implants with Immediate Function is Glauser (2012).[20] 102 Brånemark System Mk IV TiUnite implants were placed in 38 patients in posterior regions with predominantly soft bone. Minor guided bone regeneration (GBR) was performed for exposed implant threads in 66 sites. The CSR was 97.1% after 11 years. During the full observation period, only 3 implants were lost – all of them in the same patient and lost only a few months after implantation. Mura (2012) and George et al. (2011) report CSR values of 100% and 99% after 5 and 9 years, respectively.[27,21] George et al. analyzed 100 TiUnite implants placed in the maxilla or mandible of 24 consecutive patients. These results compare favorably to those reported in the literature with conventional loading protocols.

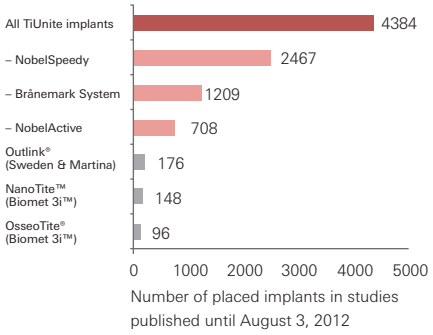
Partially edentulous patients

Immediately loaded single-tooth and multiple-unit restorations with implants show excellent results, even when occlusal contact is established from the start. A reason for this may be the neighboring teeth, which share the occlusal load and provide a neural reflex input, originating from the periodontal mechanoreceptors. Calandriello and Tomatis (2011) report on single-tooth replacements in 33 patients in the molar area, often subjected to high chewing forces.[24] The 40 Brånemark System Mk III TiUnite implants with wide platform were immediately loaded with temporary crowns with full centric occlusal contact. Even with a normal diet (with the exception of very hard food) only two implants were lost. This resulted in a CSR of 95% at 5-year follow-up.

Full-arch restorations with All-on-4 treatment concept

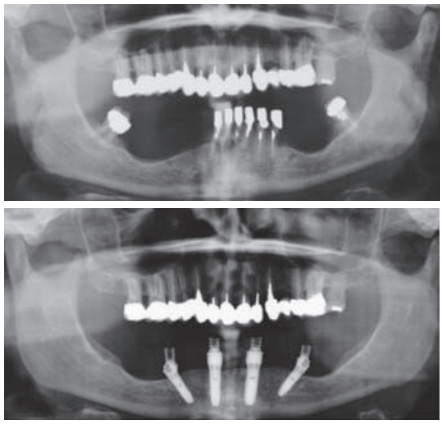
The All-on-4 treatment concept offers a reliable outcome for the rehabilitation of edentulous jaws. In this concept, four implants (two straight ones in the anterior and two tilted ones in the posterior) are immediately loaded with a fixed full-arch prosthesis. All but one of all available studies on the All-on-4 treatment concept with a minimum follow-up of 1 year demonstrate very high CSR values. In their systematic review, Patzelt et al. (2013) report CSR for implants and prostheses of 99.0% (± 1.0%) and 99.9% (± 0.3%) at 36 months, respectively.[35] With very few exceptions, fixed provisional acrylic prostheses were installed within 48 hours in all studies. Almost all restorations were performed with TiUnite surface implants, rendering the reporting on other implant types anecdotal. According to the authors, the rationale for the All-on-4 treatment concept is that it is cost-effective, decreases treatment times, and results in a higher quality of life for patients.

TiUnite implants are the implants of choice for the All-on-4 treatment concept



Systematic review of all clinical studies on All-on-4 treatment concept shows that Nobel Biocare implants with TiUnite surface are predominantly used for this type of full-arch restoration (illustration adapted from Patzelt et al. 2013).[35]

Immediate improvement of quality of life
Case from Agliardi et al. (2010)[36]



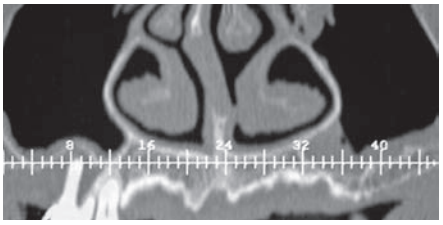
Pre-operative and post-surgical OPG of a patient receiving a provisional functional acrylic prosthesis the day of surgery according to the All-on-4 treatment concept.

Agliardi et al. (2010) also report very high CSR at 1-year follow-up for full-arch restorations in 173 patients with two tilted distal and two axial anterior Brånemark System Mk IV or NobelSpeedy Groovy implants, which were immediately loaded with a provisional acrylic prosthesis on the day of surgery.[36] 93 prostheses were anchored in the mandible and 61 prostheses in the maxilla. The final prosthesis was installed 4–6 months later. CSR values were 98.4% for the maxilla and 99.7% for the mandible. Francetti et al. (2012) even report a CSR of 100% for both maxilla and mandible at mean follow-up of 33.8 and 52.8 months, respectively.[37] In addition, they report no significant difference in marginal bone level changes between axial and tilted implants, and between mandible and maxilla.

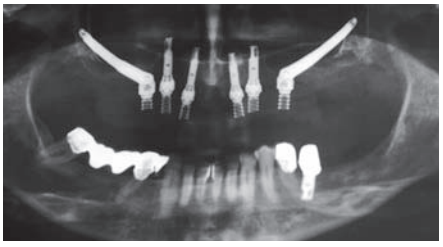
Immediate Function with zygomatic implants in the resorbed maxilla

Immediate Function is also an option in patients with very limited jaw bone volume, as long as appropriate implants are used. In such cases, the increase in quality of life is very pronounced, as conventional procedures would be very lengthy due to the otherwise required extensive bone grafting procedures. In their 5-year prospective study, Davo et al. (2013) report on 42 consecutive patients with fully or partially edentulous maxillae.[38] They installed 81 machined or TiUnite Brånemark System Zygoma implants in the posterior and 140 standard TiUnite implants in the frontal region. Exclusion criteria were the presence of enough maxillary bone to be rehabilitated with standard implants, heavy smoking, diabetes or other metabolic disorders and acute sinusitis. A fixed acrylic prosthesis reinforced with metal wire was installed on the day of surgery. A soft diet was prescribed for one month. Only one machined zygomatic implant had to be removed after 3 years due to loss of osseointegration. One patient developed acute sinusitis immediately after implant placement. The CSR for zygomatic implants was 98.5%, and for the standard implants 94.9%.

Graftless implant solution for the resorbed maxilla
Case from Davo et al. (2013)[38]



CT scan shows resorption of maxillary bone.



Postoperative panoramic radiograph shows two Brånemark System Zygoma and four standard implants. They support a fixed provisional bridge in acrylic.

Rapid increase in quality of life.

Immediate Function has the potential to shorten healing times, minimize the number of appointments and reduce costs. In addition, it has a positive effect on the patients' quality of life, as the improvements in function, esthetics, sense, speech and self-esteem occur sooner than with any other loading protocol.

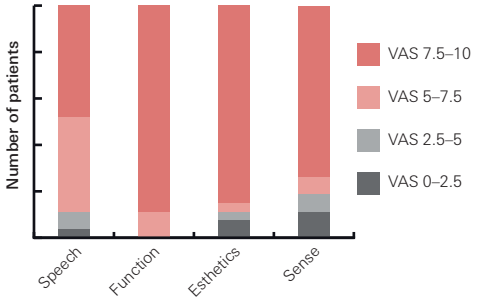
Delayed loading prolongs treatment time

In their study on single implants in the anterior maxilla, Den Hartog et al. (2011) report on patient feedback. Although overall satisfaction was similar in patients with conventional loading and those with immediate loading, almost one third of the patients with conventional loading described their experience of the healing time as "long".[29]

High increase in quality of life

In a prospective multicenter study with three centers (two university-based), van Steenberghe et al. (2005) report on 27 consecutive patients with edentulous maxillae.[39] 184 Brånemark System Mk III TiUnite implants were placed flapless by means of guided surgery and immediately loaded with fixed individualized CAD/CAM prostheses, which distributed the occlusal forces evenly. At 3-month follow-up, a quality of life (QOL) assessment was performed. Patients were highly satisfied with regards to function, esthetics and sense, whereas the improvement of speech was slower. The effect of immediate restoration of edentulous jaws on speech was further investigated by the same team in another group of 10 patients treated with the same rehabilitation protocol.[40] Patients were examined by a series of speech pathologists and by means of automated speech analysis. They returned to their pre-surgical articulation level after 1 to 6 months. This contrasts with the previous findings of Lundqvist et al. (1992), who report a 3-year adaptation period for speech with conventional loading protocols.[41] It appears that an immediate restoration of edentulism leads to a fast, progressive and ongoing improvement in patients' quality of life.

High increase in quality of life already in the first months after implant treatment

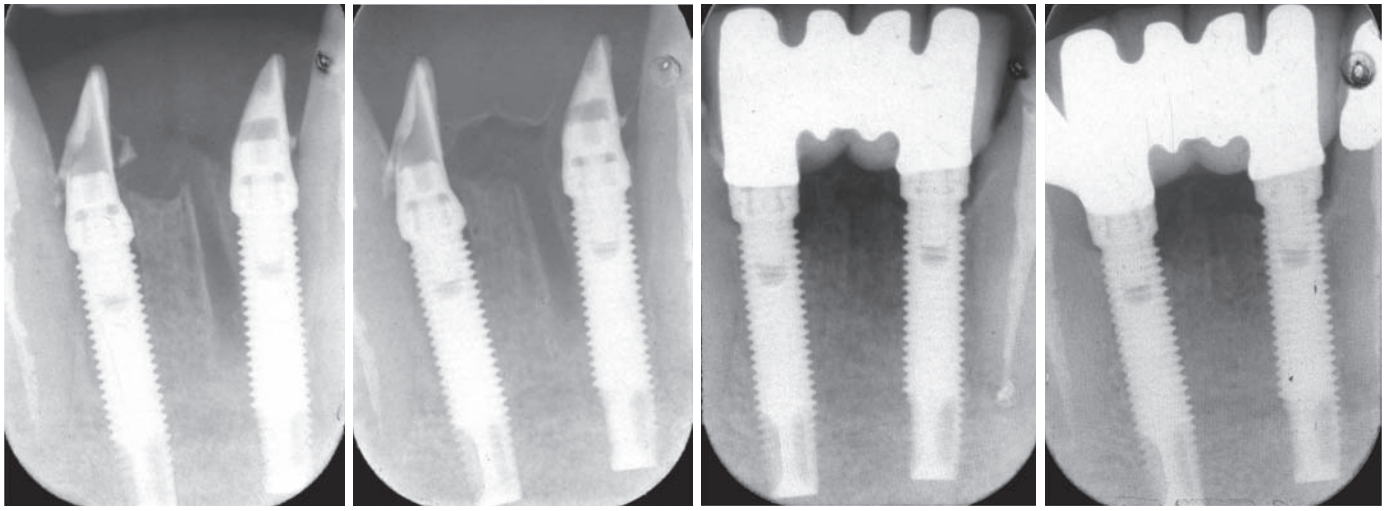


Only 3 months after implant placement, 27 patients assessed speech, function, esthetics and sense on a visual analog scale (VAS) from 1–10 (10 being optimal outcome). (Illustration adapted from van Steenberghe et al. 2005)[39]

10-year follow-up of immediately loaded implants with TiUnite porous anodized surface

Degidi M, Nardi D, Piattelli A
Clin Implant Dent Relat Res 2012;14:828-838

Periapical radiographs



Day of surgery. 6 months after surgery. After placement of final restoration. 10 years after surgery.

Original abstract

Background: The immediate loading of implants with a porous anodized surface is a well-described technique. Few data are however available on the long-term outcomes.

Purpose: The aim of this prospective study was to assess the 10-year performance of TiUnite implants supporting fixed prostheses placed with an immediate loading approach in both postextractive and healed sites.

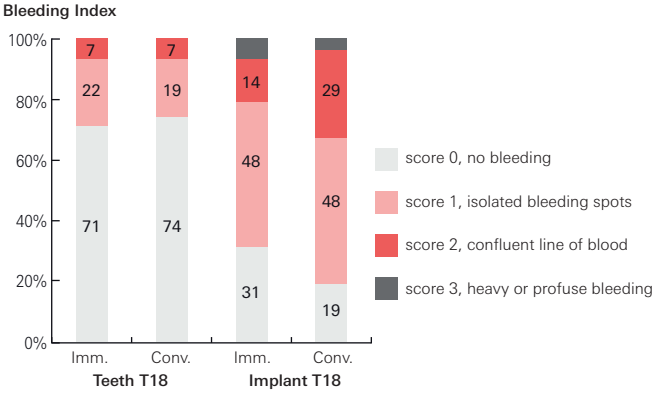
Materials and methods: All patients received a fixed provisional restoration supported by immediately loaded parallel design, self-tapping implants with a porous anodized TiUnite surface, and an external-hexagonal connection. Both healed and postextractive cases were included. Success and survival rate for restorations and implants, changes in marginal peri-implant bone level, probing depth measurements, biological or technical complications, and any other adverse events were recorded at yearly follow-up up to 10 years after surgery.

Results: A total of 210 implants fulfilled the inclusion criteria and were consecutively placed in 59 patients. Forty-seven (22.38%) implants were lost because the recalled patient refused to attend the planned 10-year follow-up. Five of 210 (2.38%) implants were lost. At the final follow-up, the accumulated mean marginal bone loss and probing depth were, respectively, 1.93 mm (SD 0.40) and 2.54 mm (SD 0.44) for the implants placed in healed sites (n=84); 1.98 mm (SD 0.37) and 2.63 mm (SD 0.39) for the implants placed in postextractive sites (n=74). The restorations examined achieved a cumulative 65.26% success rate and 97.96% survival rate. The implants placed in healed and postextractive sites, respectively, achieved a 98.05% and a 96.52% cumulative survival rate.

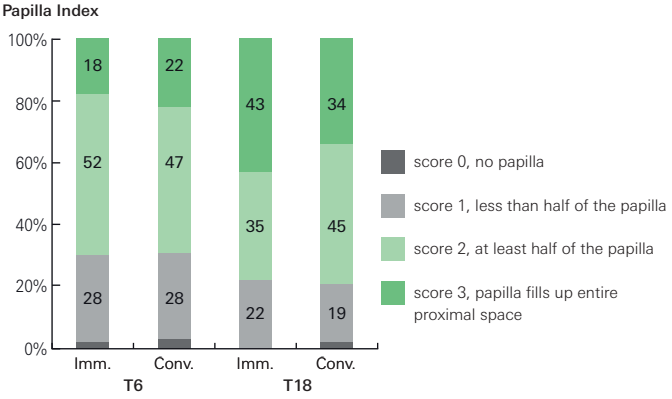
Conclusions: Positive results in terms of bone maintenance in the long-term perspective are to be expected using immediately loaded implants with a TiUnite porous anodized surface in both postextractive and healed sites when adequate levels of oral hygiene are kept.

Immediate non-occlusal loading of single implants in the aesthetic zone: a randomized clinical trial

Den Hartog L, Raghoebar GM, Stellingsma K, Vissink A, Meijer HJ
J Clin Periodontol. 2011;38:186-194



Bleeding index scores for implants and adjacent teeth 18 months after implant placement. Imm. = immediate group; Conv. = conventional group.



Papilla index scores 6 and 18 months after implant placement. Imm. = immediate group; Conv. = conventional group.

Clinical relevance

Scientific rationale for the study: Dental implants are widely used to replace missing anterior teeth. Placement of the crown immediately after implant installation offers several advantages for the patient compared with a conventional loading strategy.

Principal findings: There were no differences in short-term treatment outcome between anterior single implants that were immediately loaded with a non-occluding temporary crown and implants that were loaded according to a conventional strategy.

Practical implications: Immediate non-occlusal loading of single implants in the anterior maxilla is a reliable strategy compared with conventional loading and should be considered as an alternative to conventional loading. However, the concept of immediate non-occlusal loading should be performed according to a specified protocol.

Original abstract

Aim: This study compared the outcome of immediate non-occlusal loading with conventional loading for single implants in the maxillary aesthetic zone. It was hypothesized that immediate non-occlusal loading is not inferior to conventional loading.

Materials and methods: Sixty-two patients with a missing maxillary anterior tooth were randomly assigned to be treated with an implant that was either restored with a non-occluding temporary crown within 24 h after implant placement (the "immediate group") or was restored according to a two-stage procedure after 3 months (the "conventional group"). All implants were installed in healed sites. Follow-up visits were conducted after 6 and 18 months post-implant placement. Outcome measures were radiographic marginal bone-level changes, survival, soft tissue aspects (probing depth, plaque, bleeding, soft tissue level), aesthetics and patient satisfaction.

Results: No significant differences were found between both study groups regarding marginal bone loss (immediate group 0.91 ± 0.61 mm, conventional group 0.90 ± 0.57 mm), survival (immediate group 96.8%: one implant lost, conventional group 100%), soft tissue aspects, aesthetic outcome and patient satisfaction.

Conclusions: Within the limitations of this study (sample size, follow-up duration), it was demonstrated that, for single implants in the anterior maxilla, the outcome of immediate non-occlusal loading was not less favourable than conventional loading.

References.

1 van Steenberghe D, Naert I, Andersson M, Brajnovic I, Van Cleynenbreugel J, Suetens P. A custom template and definitive prosthesis allowing immediate implant loading in the maxilla: a clinical report. Int J Oral Maxillofac Implants. 2002;17:663-670

2 Esposito M, Grusovin MG, Willings M, Coulthard P, Worthington HV. The effectiveness of immediate, early, and conventional loading of dental implants: a Cochrane systematic review of randomized controlled clinical trials. Int J Oral Maxillofac Implants 2007;22:893-904

3 Esposito M, Grusovin MG, Maghaireh H, Worthington HV. Interventions for replacing missing teeth: different times for loading dental implants. Cochrane Database Syst Rev. 2013;3:CD003878

4 Cochran DL, Morton D, Weber HP. Consensus statements and recommended clinical procedures regarding loading protocols for endosseous dental implants. Int J Oral Maxillofac Implants. 2004;19 Suppl:109-13

5 Piattelli A, Trisi P, Romasco N, Emanuelli M. Histologic analysis of a screw implant retrieved from man: influence of early loading and primary stability. J Oral Implantol. 1993;19:303-6

6 Arnhart C, Kielbassa AM, Martinez-de Fuentes R, Goldstein M, Jackowski J, Lorenzoni M, Maiorana C, Mericske-Stern R, Pozzi A, Rompen E, Sanz M, Strub JR. Comparison of variable thread tapered implant designs to a standard tapered implant design after immediate loading. A 3-year multicenter randomized controlled trial. Eur J Oral Implantol. 2012;5:123-136

7 Balshi TJ, Wolfinger GJ. Immediate loading of Brånemark implants in edentulous mandibles: a preliminary report. Implant Dent. 1997;6:83-88

8 Schnitman PA, Wohrle PS, Rubenstein JE. Immediate fixed interim prostheses supported by two-stage threaded implants: methodology and results. J Oral Implantol 1990;16:96-105

9 Irinakis T, Wiebe C. Initial torque stability of a new bone condensing dental implant: a cohort study of 140 consecutively placed implants. J Oral Implantol. 2009;35:277-282

10 Kolinski ML, Cherry JE, McAllister BS, Parrish KD, Pumphrey DW, Schroering RL. Evaluation of a variable-thread tapered implant in extraction sites with immediate temporization: A 3-year multi-center clinical study. J Periodontol. 2013 [Epub ahead of print]

11 Aspriello SD, Rasicci P, Ciolino F, Zizzi A, Rubini C, Procaccini M, Piemontese M. Immediate loading of NobelActive implants in postmenopausal osteoporotic women: 2-years follow up study. Clin Oral Implants Res 2011 22:Abstract 222

12 Glauser R, Portmann M, Ruhstaller P, Lundgren AK, Hämmerle C, Gottlow J. Stability measurements of immediately loaded machined and oxidized implants in the posterior maxilla. A comparative clinical study using resonance frequency analysis. Appl Osseointegration Res 2001;2:27–29

13 Albrektsson T, Johansson C, Lundgren AK, Sul Y, Gottlow J. Experimental studies on oxidized implants. A histomorphometrical and biomechanical analysis. Appl Osseointegration Res 2000;1:21–24

14 Rocci A, Rocci M, Rocci C, Scoccia A, Gargari M, Martignoni M, Gottlow J, Sennerby L. Immediate loading of Brånemark system TiUnite and machined-surface implants in the posterior mandible, part II: a randomized open-ended 9-year follow-up clinical trial. Int J Oral Maxillofac Implants. 2013;28:891-5

15 Calandriello R, Tomatis M, Rangert B. Immediate functional loading of Brånemark System implants with enhanced initial stability: a prospective 1- to 2-year clinical and radiographic study. Clin Implant Dent Relat Res. 2003; 5 Suppl 1:10-20

16 Maló P, Rangert B, Dvärsäter L. Immediate function of Brånemark implants in the esthetic zone: a retrospective clinical study with 6 months to 4 years of follow-up. Clin Implant Dent Relat Res. 2000;2:138-146

17 Kielbassa AM, Martinez-de Fuentes R, Goldstein M, Arnhart C, Barlattani A , Jackowski J, Knauf M, Lorenzoni M, Maiorana C, Mericske-Stern R, Rompen R, Sanz M: Randomized controlled trial comparing a variable-thread novel tapered and a standard tapered implant: interim one-year results J Prosthet Dent 2009;101:293-305

18 Albrektsson T, Brånemark PI, Hansson HA, Lindström J. Osseointegrated titanium implants. Requirements for ensuring a long-lasting, direct bone-to-implant anchorage in man. Acta Orthop Scand. 1981;52:155-70

19 Degidi M, Nardi D, Piattelli A. 10-year follow-up of immediately loaded implants with TiUnite porous anodized surface. Clin Implant Dent Relat Res 2012;14:828-838

20 Glauser R. Eleven-year results of implants with an oxidized surface placed predominantly in soft bone and subjected to immediate occlusal loading. Clin Oral Implants Res 2012;23 suppl 7;140-141

21 George KM, Choi YG, Rieck KL, Van Ess J, Ivancakova R, Carr AB. Immediate restoration with ti-unite implants: practice-based evidence compared with animal study outcomes. Int J Prosthodont 2011;24:199-203

22 Migliorança RM, Sotto-Maior BS, Senna PM, Francischone CE, Del Bel Cury AA. Int J Oral Maxillofac Surg. 2012;41:1072-6

23 Noelken R, Kunkel M, Jung BA, Wagner W. Immediate Nonfunctional Loading of NobelPerfect Implants in the Anterior Dental Arch in Private Practice - 5-Year Data. Clin Implant Dent Relat Res. 2012 [Epub ahead of print]

24 Calandriello R, Tomatis M. Immediate occlusal loading of single lower molars using Brånemark System® Wide Platform TiUnite™ implants: a 5-year follow-up report of a prospective clinical multicenter study. Clin Implant Dent Relat Res. 2011;13:311-318

25 Jokstad A, Alkumru H. Immediate function on the day of surgery compared with a delayed implant loading process in the mandible: a randomized clinical trial over 5 years. Clin Oral Implants Res [Epub ahead of print]

26 Maló P, de Araújo Nobre M, Lopes A, Francischone C, Rigolizzo M. "All-on-4" immediate-function concept for completely edentulous maxillae: a clinical report on the medium (3 years) and long-term (5 years) outcomes. Clin Implant Dent Relat Res. 2012;14 Suppl 1:e139-150

27 Mura P. Immediate loading of tapered implants placed in postextraction sockets: retrospective analysis of the 5-year clinical outcome. Clin Implant Dent Relat Res. 2012;14:565-574

28 Meloni SM, De Riu G, Pisano M, De Riu N, Tullio A. Immediate versus delayed loading of single mandibular molars. One-year results from a randomised controlled trial. Eur J Oral Implantol. 2012;5:345-353

29 Den Hartog L, Raghoebar GM, Stellingsma K, Vissink A, Meijer HJ. Immediate non-occlusal loading of single implants in the aesthetic zone: a randomized clinical trial. J Clin Periodontol. 2011 Feb;38:186-194

30 De Rouck T, Collys K, Wyn I, Cosyn J. Instant provisionalization of immediate single-tooth implants is essential to optimize esthetic treatment outcome. Clin Oral Implants Res. 2009;20:566-570

31 Landázuri-Del Barrio RA, Cosyn J, De Paula WN, De Bruyn H, Marcantonio E Jr. A prospective study on implants installed with flapless-guided surgery using the all-on-four concept in the mandible. Clin Oral Implants Res 2013;24:428–433

32 Sanna AM, Molly L, van Steenberghe D. Immediately loaded CAD-CAM manufactured fixed complete dentures using flapless implant placement procedures: a cohort study of consecutive patients. J Prosthet Dent. 2007;97:331-339

33 Schincaglia GP, Marzola R, Giovanni GF, Chiara CS, Scotti R. Replacement of mandibular molars with single-unit restorations supported by wide-body implants immediate versus delayed loading. A randomized controlled study. Int J Oral Maxillofac Implants 2008;23:474-480

34 Vasak C, Kohal RJ, Lettner S, Rohner D, Zechner W. Clinical and radiological evaluation of a template-guided (NobelGuide™) treatment concept. Clin Oral Implants Res. 2012 [Epub ahead of print]

35 Patzelt SB, Bahat O, Reynolds MA, Strub JR. The All-on-Four Treatment Concept: A Systematic Review. Clin Implant Dent Relat Res. 2013 [Epub ahead of print]

36 Agliardi E, Panigatti S, Clerico M, Villa C, Malo P. Immediate rehabilitation of the edentulous jaws with full fixed prostheses supported by four implants: interim results of a single cohort prospective study. Clin Oral Implants Res 2010;21:459–465

37 Francetti L, Romeo D, Corbella S, Taschieri S, Del Fabbro M. Bone level changes around axial and tilted implants in full-arch fixed immediate restorations. Interim results of a prospective study. Clin Implant Dent Relat Res. 2012;14:646-654

38 Davó R, Malevez C, Pons O. Immediately loaded zygomatic implants: a 5-year prospective study. Eur J Oral Implantol 2013;6:1–9

39 van Steenberghe D, Glauser R, Blombäck U, Andersson M, Schutyser F, Pettersson A, Wendelhag I. A computed tomographic scan-derived customized surgical template and fixed prosthesis for flapless surgery and immediate loading of implants in fully edentulous maxillae: a prospective multicenter study. Clin Implant Dent Relat Res. 2005;7 Suppl 1:111-120

40 Molly L, Nackaerts O, Vandewiele K, Manders E, van Steenberghe D, Jacobs R. Speech adaptation after treatment of full edentulism through immediate loaded implant protocols. Clin Oral Implants Res 2008;19:86–90

41 Lundqvist S, Lohmander-Agerskov A, Haraldson T. Speech before and after treatment with bridges on osseointegrated implants in the edentulous upper jaw. Clin Oral Implants Res 1992;3:57-62

Overview of studies – Immediate Function.

The following overview groups non-comparative clinical studies on TiUnite implants following an Immediate Function protocol according to follow-up time. Within each group, the studies are listed alphabetically according to first author, and by publication date. Studies with comparative data are listed in separate tables: TiUnite implants following Immediate Function versus other loading protocols see page 24; implants with TiUnite versus machined surface see page 26.

Only peer-reviewed clinical studies with at least 10 patients and at least one year of follow-up are listed. Abstracts, reviews, single case reports, technique descriptions, and animal and in vitro tests are excluded.

For more information on all studies on Immediate Function visit:
nobelbiocare.com/scientific-evidence or PubMed at pubmed.gov

Reference	Follow-up time	TiUnite implant	Study type	Indication/study focus	Number of patients*	Number of implants*	CSR %**
Follow-up time >5 years							
Degidi M, Nardi D, Piattelli A (2012). Clin Implant Dent Relat Res 14:828-838.	10 years	Brånemark System Mk III TiUnite	Prospective Single arm	Healed/extraction sites Immediate loading Osseointegration/bone preservation	59	210	97.6
George KM, Choi YG, Rieck KL, Van Ess J, Ivancakova R, Carr AB (2011). Int J Prosthodont 24:199-203.	9 years and more	TiUnite implants	Retrospective Single arm	Maxilla and mandible All indications Immediate loading	24	100	99
Glauser R (epub ahead 2011). Clin Implant Dent Relat Res. *Glauser R, Zembic A, Ruhstaller P, Windisch S (2007). J Prosthet Dent 97: S59-S68.* *Glauser R, Lundgren AK, Gottlow J, Sennerby L, Portmann M, Ruhstaller P, Hammerle CH (2003). Clin Implant Dent Relat Res 5 Suppl 1: 47-56.* *Glauser R, Ruhstaller P, Windisch S, Zembic A, Lundgren A, Gottlow J, Hämmerle CH (2005). Clin Implant Dent Relat Res 7 Suppl 1: S52-59.*	7 years 5 years 4 years 1 year	Brånemark System Mk IV	Prospective Single arm	Soft bone Minimally invasive Immediate loading Soft tissue health Osseointegration/bone preservation	38	102	97.1
Noelken R, Kunkel M, Jung BA, Wagner W (epub ahead 2012). Clin Implant Dent Relat Res. *Noelken R, Morbach T, Kunkel M, Wagner W (2007). Int J Periodontics Restorative Dent 27:277-285.*	65 months (mean, range 55-78 months) Up to 27 months	NobelPerfect	Retrospective Single arm	Single teeth, esthetic area Minimally invasive Immediate loading Soft tissue health Osseointegration/bone preservation	20	31	96.8

*Includes all eligible patients that received the TiUnite implant type(s) stated. Non-TiUnite implants are not reported in the table.
**If the CSR is not reported separately in the study, the percentage of surviving implants was calculated.

Reference	Follow-up time	TiUnite implant	Study type	Indication/study focus	Number of patients*	Number of implants*	CSR %**
Follow-up time 3–5 years							
Agliardi EL, Pozzi A, Stappert CF, Benzi R, Romeo D, Gherlone E (epub ahead 2012). Clin Implant Dent Relat Res.	4.6 years (mean, range 3–6.5 years)	Brånemark System Mk IV (n=30) NobelSpeedy Groovy (n=162)	Prospective	Edentulous and atrophic maxilla Immediate loading Soft tissue health Osseointegration/bone preservation	32	192	98.96
Arnhart C, Kielbassa AM, Martinez-de Fuentes R, Goldstein M, Jackowski J, Lorenzoni M, Maiorana C, Mericske-Stern R, Pozzi A, Rompen E, Sanz M, Strub, J R. (2012) Eur J Oral Implantol. 5:123-136. *Kielbassa AM, Martinez-de Fuentes R, Goldstein M, Arnhart C, Barlattani A, Jackowski J, Knauf M, Lorenzoni M, Maiorana C, Mericske-Stern R, Rompen E, Sanz M. (2009) J Prosthet Dent. 101:293-305.*	36 months 12 months	NobelActive (n=199) NobelReplace Tapered (n=126)	Randomized controlled Multicenter	Healed sites Immediate loading	177	325	96.2
Butura CC, Galindo DF, Jensen OT (2011). Oral Maxillofac Surg Clin North Am 23:289-300, vi.	3 years	NobelSpeedy Groovy	Retrospective	Edentulous mandible All-on-4 treatment concept Immediate loading	219	857	99.7
Calandriello R, Tomatis M (2011). Clin Implant Dent Relat Res 13:311-318.	5 years	Brånemark System Mk III	Prospective Multicenter Single arm	Single lower molars Immediate loading Osseointegration/bone preservation	33	40	95
Cavalli N, Barbaro B, Spasari D, Azzola F, Ciatti A, Francetti L (2012). Int J Dent 2012:180379.	38.8 months (mean, range 12–73 months)	Brånemark System Mk IV NobelSpeedy Groovy	Retrospective	Edentulous maxilla All-on-4 treatment concept Immediate loading	34	136	100
Cosyn J, Eghbali A, De Bruyn H, Collys K, Cleymaet R, De Rouck T (2011). J Clin Periodontol 38:746-753.	3 years	NobelReplace Tapered	Prospective Case series	Single tooth in anterior maxilla Extraction sites Minimally invasive Immediate loading Esthetics Soft tissue health Osseointegration/bone preservation	30	30	96
Degidi M, Perrotti V, Piattelli A (2006). Clin Implant Dent Relat Res 8:169-177.	3 years	Brånemark System Mk III (n=127) and Mk IV (n=15)	Prospective Comparative	Edentulous maxilla and mandible Minimally invasive Immediate loading Osseointegration/bone preservation	29	142	100
Finne K, Rompen E, Toljanic J (2012). Int J Oral Maxillofac Implants 27:458-466. *Finne K, Rompen E, Toljanic J (2007). J Prosthet Dent 97:S79-S85.* *Finne K, Rompen E, Toljanic J (2007). Int J Oral Maxillofac Implants 22:226-234.*	3 years 2 years 1 year	NobelDirect	Prospective Multicenter	All indications, mandible Minimally invasive Flap/flapless Immediate loading Soft tissue health Osseointegration/bone preservation	56	82	98.8
Francetti L, Romeo D, Corbella S, Taschieri S, Del Fabbro M (2012). Clin Implant Dent Relat Res 14:646-654.	52.8 months (mean, range 30–66 months)	Brånemark System Mk IV (n=92) NobelSpeedy Groovy (n=104)	Prospective	Edentulous maxilla and mandible All-on-4 treatment concept Immediate loading Osseointegration/bone preservation	47	196	100
Hahn J (2011). J Oral Implantol 37:259-265. *Hahn JA (2007). J Oral Implantol 33:152-155.* *Hahn J (2006). EDI supplement:12-15.*	Up to 4 years 3 years Up to 2 years	NobelDirect	Prospective Monocenter	Partially edentulous Minimally invasive Immediate loading Osseointegration/bone preservation	30	47	97.9

Reference	Follow-up time	TiUnite implant	Study type	Indication/study focus	Number of patients*	Number of implants*	CSR %**
Kolinski ML, Cherry JE, McAllister BS, Parrish KD, Pumphrey DW, Schroering RL. (epub ahead 2013) J Periodontol. *McAllister BS, Cherry JE, Kolinski ML, Parrish KD, Pumphrey DW, Schroering RL (2012). Int J Oral Maxillofac Implants 27:611-618.*	3 years 2 years	NobelActive	Prospective Multicenter Single arm	Partially edentulous Extraction sites Minimally invasive Immediate loading Soft tissue health Osseointegration/bone preservation	55	60	98.3
Kronstrom M, Davis B, Loney R, Gerrow J, Hollender L (epub ahead 2012). Clin Implant Dent Relat Res. *Kronström M, Davis B, Loney R, Gerrow J, Hollender L (2010). Int J Oral Maxillofac Implants 25:181-188.*	3 years 1 year	Brånemark System	Prospective Randomized controlled Monocenter	Edentulous mandible Implant overdenture on ball attachments (one vs. two implants) Immediate loading Osseointegration/bone preservation	36	55	81.8
Malo P, de Araujo Nobre M, Lopes A, Francischone C, Rigolizzo M (2012). Clin Implant Dent Relat Res 14 Suppl 1: e139-150.	5 years	Brånemark System Mk III TiUnite (n=21) and Mk IV (n=82) NobelSpeedy (n=865)	Retrospective Single arm	Edentulous maxilla All-on-4 treatment concept Immediate loading Osseointegration/bone preservation	242	968	98
Maló P, Nobre Md, Lopes A, Francischone C, Rigolizzo M (2012). Eur J Oral Implantol. 5:37-46.	3 years	Brånemark System Zygoma	Retrospective Cohort study Monocenter Single arm	Edentulous atrophic maxilla Immediate loading	39	92	100
Mura P (2012). Clin Implant Dent Relat Res 14: 565-574.	5 years	Replace Select Tapered	Retrospective Monocenter	Extraction sites Minimally invasive Immediate loading Soft tissue health Osseointegration/bone preservation	56	79	100
Paul S, Held U (epub ahead 2012). Clin Oral Implants Res.	3.4 years (mean, range 1.5–5.5 years)	NobelPerfect	Retrospective Single arm	Single anterior tooth Extraction sites Minimally invasive Immediate loading Soft tissue health Osseointegration/bone preservation	26	31	100
Follow-up time < 3 years							
Agliardi E, Panigatti S, Clerico M, Villa C, Malo P (2010). Clin Oral Implants Res 21:459-465.	31.3 months (mean, range 4–59 months)	Brånemark System Mk IV (n=92) NobelSpeedy Groovy (n=600)	Prospective	Edentulous maxilla (Max) and mandible (Man) Immediate loading Soft tissue health Osseointegration/bone preservation	173	692	99.2 Max: 98.4 Man: 99.7
Agliardi E, Clerico M, Ciancio P, Massironi D (2010). Quintessence Int 41:285-293.	30.1 months (mean, range 14–44 months)	Brånemark System Mk IV (n=16) NobelSpeedy Groovy (n=80)	Prospective Single arm	Edentulous atrophic mandible All-on-4 treatment concept Immediate loading Soft tissue health Osseointegration/bone preservation	24	96	100
Agliardi EL, Francetti L, Romeo D, Del Fabbro M (2009). Int J Oral Maxillofac Implants 24:887-895.	27.2 months (mean, range 18–42 months)	Brånemark System Mk IV (n=30) NobelSpeedy Groovy (n=90)	Prospective Single arm	Edentulous maxilla Immediate loading Soft tissue health Osseointegration/bone preservation	20	120	100
Agliardi EL, Francetti L, Romeo D, Taschieri S, Del Fabbro M (2008). Minerva Stomatol 57:251-259, 259-263.	1.7 years (mean, range 0.3–2.9 years)	Brånemark System Mk IV (n=30) NobelSpeedy Groovy (n=96)	Prospective Single arm	Edentulous maxilla Minimally invasive Immediate loading Soft tissue health	21	126	100
Antoun H, Belmon P, Cherfane P, Sitbon JM (2012). Int J Periodontics Restorative Dent 32: e1-9.	17.6 months (mean, range 3–56 months)	Brånemark System TiUnite	Retrospective Single arm	Edentulous maxilla and mandible Immediate loading Osseointegration/bone preservation	44	205	98.5
Attard NJ, David LA, Zarb GA (2005). Int J Prosthodont 18:463-470.	1 year	Brånemark System TiUnite (n=70)	Prospective	Edentulous mandible Bar-retained overdenture Immediate loading	35	70	98.6

*Includes all eligible patients that received the TiUnite implant type(s) stated. Non-TiUnite implants are not reported in the table.

**If the CSR is not reported separately in the study, the percentage of surviving implants was calculated.

Reference	Follow-up time	TiUnite implant	Study type	Indication/study focus	Number of patients*	Number of implants*	CSR %**
Babbush CA, Brokloff J (2012). Implant Dent 21:28-35.	Up to 31 months	NobelActive	Retrospective Monocenter	Fully and partially edentulous Immediate loading	293	1001	97.4
Babbush C, Kutsko G, Brokloff J (2011). J Oral Implantol 37:431-445.	29 months	NobelActive	Retrospective Monocenter Single arm	Edentulous maxilla (Max) and mandible (Man) Extraction and healed sites All-on-4 treatment concept Minimally invasive Immediate loading	165	708 Max: 436 Man: 272	99.6 Max: 99.3 Man: 100
Botos S, Yousef H, Zweig B, Flinton R, Weiner S (2011). Int J Oral Maxillofac Implants 26:492-498.	1 year	Replace Select	Prospective Comparative	Edentulous mandible Ball-retained overdenture Immediate loading Soft tissue health Osseointegration/bone preservation Comparison reg. collar textures	15	15	93.3
Calandriello R, Tomatis M, Vallone R, Rangert B, Gottlow J (2003). Clin Implant Dent Relat Res 5 Suppl 1:74-80.	0.5–1 year	Brånemark System Mk III	Prospective Multicenter Single arm	Single molars in mandible Immediate loading Osseointegration/bone preservation	44	50	100
Cosyn J, De Bruyn H, Cleymaet R (epub ahead 2012). Clin Implant Dent Relat Res.	1 year	NobelActive	Prospective Single arm	Single extraction sites Esthetics Soft tissue health Immediate loading Osseointegration/bone preservation	22	22	95.5
Cricchio G, Imburgia M, Sennerby L, Lundgren S (epub ahead 2013). Clin Implant Dent Relat Res.	2 years	Brånemark System Mk III (n=10) and Groovy (n=11)	Single arm	Posterior atrophic maxilla Sinus membrane elevation Immediate loading Osseointegration/bone preservation	10	21	100
De Rouck T, Collys K, Cosyn J (2008). J Clin Periodontol 35:649-657.	1 year	NobelReplace Tapered	Prospective	Anterior maxilla Single tooth restoration Extraction sites Minimally invasive Immediate loading Soft tissue health Osseointegration/bone preservation	30	30	97
Degidi M, Nardi D, Piattelli A, Malevez C (2012). Int J Periodontics Restorative Dent 32:e154-161.	1 year	Brånemark System Zygoma	Prospective Single arm	Edentulous atrophic maxilla Zygomatic implants Intraoral welding technique Immediate loading Osseointegration/bone preservation	10	20	100
Deng F, Zhang H, Shao H, He Q, Zhang P (2010). Int J Oral Maxillofac Implants 25:1036-1040.	1 year	Brånemark System Mk III NobelSpeedy	Prospective Comparative Non-randomized	Edentulous jaws Periodontally compromised Healed vs. extraction sites Minimally invasive Immediate loading Osseointegration/bone preservation	12	84	95.2
Francetti L, Agliardi E, Testori T, Romeo D, Taschieri S, Fabbro MD (2008). Clin Implant Dent Relat Res 10:255-263.	22.4 months (mean, range 6–43 months)	Brånemark System Mk IV (n=116) NobelSpeedy (n=132)	Prospective Single arm	Edentulous mandible All-on-4 treatment concept Minimal invasive Immediate loading Soft tissue health Osseointegration/bone preservation Patient satisfaction	62	248	100
Galindo DF, Butura CC (2012). Int J Oral Maxillofac Implants 27:628-633.	1.3–1.5 years	NobelSpeedy Groovy (n = 672) NobelActive (n = 60)	Retrospective Single arm	Edentulous mandible All-on-4 treatment concept Immediate loading Osseointegration/bone preservation	183	732	99.86
Hartlev J, Kohberg P, Ahlmann S, Gotfredsen E, Andersen NT, Isidor F, Schou S (2013). Clin Oral Implants Res 24:652-658.	2.8 years (mean, range 0.9–7.4 years)	Replace Select Tapered	Retrospective Monocenter	Single tooth restorations Extraction sites Minimally invasive Immediate loading Soft tissue health Osseointegration/bone preservation	55	55	98

Reference	Follow-up time	TiUnite implant	Study type	Indication/study focus	Number of patients*	Number of implants*	CSR %**
Johansson B, Friberg B, Nilson H (2009). Clin Implant Dent Relat Res 11:194-200.	1 year	Brånemark System Mk III TiUnite	Prospective Multicenter Single arm	Edentulous maxilla Minimally invasive Immediate loading Procera Implant Bridge NobelGuide Osseointegration/bone preservation	52	312	99.4
Kacer CM, Dyer JD, Kraut RA (2010). J Oral Maxillofac Surg 68:2861-2867.	2 years	Replace Select	Retrospective Single arm	Mandible All types of indications Immediate loading	Not reported	127	99.3
Kan JY, Rungcharassaeng K, Morimoto T, Lozada J (2009). J Oral Maxillofac Surg 67 suppl 11:40-48.	2.15 years (mean, range 1–4 years)	NobelReplace Tapered (n=14) NobelPerfect (n=6)	Single arm	Extraction sites Connective tissue grafting Immediate loading Soft tissue health Osseointegration/bone preservation	20	20	100
Kan JY, Rungcharassaeng K, Sclar A, Lozada JL (2007). J Oral Maxillofac Surg 65 suppl 1:13-19.	1 year	Replace Select Tapered NobelPerfect	Prospective Single arm	Anterior maxilla Single-tooth restorations Guided bone regeneration Minimally invasive Immediate loading Osseointegration/bone preservation	23	23	100
Kan JY, Rungcharassaeng K, Liddelow G, Henry P, Goodacre CJ (2007). J Prosthet Dent 97:S109-118.	1 year	NobelPerfect	Prospective Pilot study Multicenter	Maxillary single tooth restorations Healed and extraction sites Minimally invasive Immediate loading Soft tissue health Osseointegration/bone preservation	29	38	100
Komiyama A, Klinge B, Hultin M (2008). Clin Oral Implants Res 19:677-685. *Komiyama A, Hultin M, Nasstrom K, Benchimol D, Klinge B (2012). Clin Implant Dent Relat Res 14:157-169.*	19 months (mean, range 6–44 months) ≥1 year	Brånemark System Mk III	Prospective Single arm	Edentulous Immediate loading Minimally invasive NobelGuide Soft tissue health Osseointegration/bone preservation	29	176	89
Landazuri-Del Barrio RA, Cosyn J, De Paula WN, De Bruyn H, Marcantonio E, Jr. (2013). Clin Oral Implants Res 24:428-433.	1 year	NobelSpeedy Replace	Prospective Single arm	Edentulous mandible All-on-4 treatment concept Minimally invasive Flapless guided surgery Immediate loading Soft tissue health Osseointegration/bone preservation	16	64	90
Li W, Chow J, Hui E, Lee PK, Chow R (2009). J Oral Maxillofac Surg 67:2653-2662.	29.5 months (mean, range 11.5–71 months)	Brånemark System Mk III (n=256) Brånemark System Mk IV and NobelSpeedy (n=64) Replace Select and Nobel-Replace Straight (n=11) Replace Select and Nobel-Replace Tapered (n=359)	Retrospective Single arm	Edentulous maxilla (Max) and mandible (Man) Immediate loading Osseointegration/bone preservation	111	690 Max: 319 Man: 371	98.7 Man: 98.7 Max: 98.7
Liao KY, Kan JY, Rungcharassaeng K, Lozada JL, Herford AS, Goodacre CJ (2010). Int J Oral Maxillofac Implants 25:784-790.	1 year	Replace Select TC with 3 mm machined collar	Prospective Pilot study Single arm	Edentulous mandible Ball-retained overdenture Minimally invasive Immediate loading Soft tissue health Osseointegration/bone preservation	10	17	94
Malo P, Nobre Mde A, Lopes A (2012). Int J Oral Maxillofac Implants 27:1177-1190.	2 years (mean)	Brånemark System Mk III (n=20) and Mk IV (n=9) NobelSpeedy (n=198)	Prospective Monocenter Single arm	Edentulous maxilla and mandible All-on-4 treatment concept Immediate loading Osseointegration/bone preservation	142	227	96.9
Malo P, Nobre Mde A, Lopes I (2008). J Prosthet Dent 100:354-366.	1 year (mean, range 0.5–1.5 years)	Zygoma prototype TiUnite (n=67) NobelSpeedy (n=57)	Pilot study Monocenter Single arm	Edentulous Atrophied maxilla Immediate loading	29	124	99.2

*Includes all eligible patients that received the TiUnite implant type(s) stated. Non-TiUnite implants are not reported in the table.

**If the CSR is not reported separately in the study, the percentage of surviving implants was calculated.

Reference	Follow-up time	TiUnite implant	Study type	Indication/study focus	Number of patients*	Number of implants*	CSR %**
Malo P, Nobre M (2008). Eur J Oral Implantol 1:293-304.	1 year	NobelSpeedy Groovy	Prospective Comparative	Partially edentulous maxilla and mandible Minimally invasive Flap (F) vs. Flapless (NF) Immediate loading Osseointegration/bone preservation	41	72 F: 40 NF: 32	98.6 F: 100 NF: 96.9
Malo P, de Araujo Nobre M, Lopes A (2007). J Prosthet Dent 97:S26-S34.	1.1 years (mean, range 0.5–1.8 years)	NobelSpeedy	Monocenter Single arm	Edentulous maxilla (Max) and mandible (Man) All-on-4 treatment concept Minimally invasive Flapless Immediate loading Osseointegration/bone preservation	23	92 Max: 72 Man: 20	97.8 Max: 97.2 Man: 100
Malo P, Nobre Mde A, Petersson U, Wigren S (2006). Clin Implant Dent Relat Res 8:223-232.	1.1 year (mean, 1 year and more)	NobelSpeedy	Retrospective Monocenter Single arm	Edentulous maxilla and mandible All-on-4 treatment concept Implant design Immediate loading Soft tissue health Osseointegration/bone preservation	46	189	98.9
Malo P, Rangert B, Nobre M (2005). Clin Implant Dent Relat Res 7 Suppl 1:S88-S94.	1 year	Brånemark System Mk III (n=15) and Mk IV (n=113)	Retrospective Monocenter Single arm	Edentulous maxilla All-on-4 treatment concept Minimal invasive Immediate loading Osseointegration/bone preservation	32	128	97.6
Marzola R, Scotti R, Fazi G, Schincaglia GP (2007). Clin Implant Dent Relat Res 9:136-143.	1 year	Brånemark System Mk III	Prospective Monocenter Single arm	Edentulous mandible Ball-retained overdenture Minimally invasive Immediate loading Osseointegration/bone preservation	17	34	100
Meloni SM, De Riu G, Pisano M, Cattina G, Tullio A (2010). Eur J Oral Implantol 3:245-251.	18 months	NobelReplace Tapered	Retrospective Single arm	Edentulous maxilla Minimally invasive Flapless NobelGuide Immediate loading Osseointegratio/bone preservation	15	90	97.8
Mozzati M, Arata V, Gallesio G, Mussano F, Carossa S (2013). Clin Implant Dent Relat Res 15:332-340.	2 years	Brånemark System Mk III (n=180) NobelSpeedy Groovy (n=20)	Retrospective Single arm	Edentulous mandible Extraction sites All-on-4 treatment concept Minimally invasive Immediate loading Osseointegration/bone preservation Patient satisfaction	50	200	100
Noelken R, Kunkel M, Wagner W (2011). Int J Periodontics Restorative Dent 31:175-183.	22 months (mean, range 13–36 months)	NobelPerfect (n=3) NobelPerfect Groovy (n=15)	Single arm	Extraction sites Flapless Minimally invasive Immediate loading Soft tissue health Osseointegration/bone preservation	16	18	100
Östman PO, Hellman M, Albrektsson T, Sennerby L (2007). Clin Oral Implants Res 18:409-418.	1 year and more	NobelDirect	Prospective	Maxilla and mandible Crowns and bridges Historic control group Immediate loading Osseointegration/bone preservation	48	115	94.8
Parel SM, Phillips WR (2011). J Prosthet Dent 106:359-366.	4–33 months	TiUnite implants	Retrospective Single arm	Edentulous maxilla (Max) and mandible (Man) All-on-4 treatment concept Immediate loading	285	2132 Max: 1140 Man: 992	97.8 Max: 96.5 Man: 99.3
Puig CP (2010). Eur J Oral Implantol 3:155-163.	1 year	Brånemark System Mk III Groovy (n=98) NobelSpeedy Groovy (n=97)	Retrospective Single arm	Edentulous maxilla and mandible Minimally invasive Flapless NobelGuide Immediate loading	30	195	98
Rao W, Benzi R (2007). J Prosthet Dent 97:S3-S14.	1–3 years	Replace Select Tapered	Prospective Single arm	Mandibular single molar Minimal invasive Flapless Immediate loading Osseointegration/bone preservation	46	51	100

Reference	Follow-up time	TiUnite implant	Study type	Indication/study focus	Number of patients*	Number of implants*	CSR %**
Sanna AM, Molly L, van Steenberghe D (2007). J Prosthet Dent 97:331-339.	2.2 years (mean, range 6–66 months)	Brånemark System	Retrospective	Edentulous jaws Minimally invasive Flapless NobelGuide Immediate loading Osseointegration/bone preservation Smokers (Sm) vs. non-smokers (Non-Sm)	30 Sm: 13 Non-Sm: 17	212	91.5 Sm: 81.2 Non-Sm: 98.9
Siepenkothen T (2007). J Prosthet Dent 97:S69-S78.	17 months (mean)	NobelDirect	Retrospective Monocenter Single arm	Maxilla and mandible Single tooth and partially edentulous Healed and extraction sites Immediate loading Osseointegration/bone preservation	58	92	100
van Steenberghe D, Glauser R, Blomback U, Andersson M, Schutyser F, Pettersson A, Wendelhag I (2005). Clin Implant Dent Relat Res 7 Suppl 1:S111-120.	1 year	Brånemark System Mk III TiUnite	Prospective Multicenter Single arm	Edentulous maxilla Minimally invasive NobelGuide Immediate loading Osseointegration/bone preservation	27	184	100
Weinländer M, Lekovic V, Spadijer-Gostovic S, Milicic B, Wegscheider WA, Piehslinger E (2011). Clin Oral Implants Res 22:743-752.	1 year	NobelReplace Tapered	Prospective Split-mouth Comparative	Posterior maxilla and mandible Partially edentulous Healed sites Immediate loading Soft tissue health Osseointegration/bone preservation Comparison of abutments	10	20	100
Weinstein R, Agliardi E, Fabbro MD, Romeo D, Francetti L (2012). Clin Implant Dent Relat Res 14:434-441.	30.1 months (mean, range 20–48 months)	Brånemark System Mk IV (n=12) NobelSpeedy Groovy (n=68)	Prospective Single arm	Edentulous extremely atrophic mandible All-on-4 treatment concept Immediate loading Soft tissue health Osseointegration/bone preservation Patient satisfaction	20	80	100
Zembic A, Johannesen LH, Schou S, Malo P, Reichert T, Farella M, Hammerle CH (2012). Clin Oral Implants Res 23:49-54.	1 year	NobelDirect 3.0	Prospective Multicenter Single arm	Anterior maxilla and mandible Partially edentulous Minimally invasive Small diameter Immediate loading Soft tissue health Osseointegration/bone preservation	47	57	98

*Includes all eligible patients that received the TiUnite implant type(s) stated. Non-TiUnite implants are not reported in the table.

**If the CSR is not reported in the study, the percentage of surviving implants was calculated.

Overview of studies – Immediate Function versus other loading protocols.

The following overview groups clinical studies that compare Immediate Function with other loading protocols according to follow-up time. Within each group the studies are listed alphabetically by first author, and by publication date.

Only peer-reviewed clinical studies with at least 10 patients and at least 1 year of follow-up are listed. Abstracts, reviews, single case reports, technique descriptions, and animal and in vitro tests are excluded.

For more information on all studies on Immediate Function visit: nobelbiocare.com/scientific-evidence or PubMed at pubmed.gov

Immediate Function versus delayed loading protocol

Reference	Follow-up time	Implant type	Study type	Indication/study focus	Number of patients*	Number of implants*	CSR %** Immediate loading	CSR %** Other loading protocol
Follow-up time 5 years								
Jokstad A. Alkumru H. (epub ahead 2013) Clin. Oral Impl. Res.	5 years	Brånemark System Mk III TiUnite and Mk IV	Prospective Randomized controlled	All-on-4 treatment concept Immediate (IL) vs delayed (DL) loading 1-stage Osseointegration/bone preservation	IL: 21 DL: 16§	IL: 84 DL 64§	96.4§	96.9§ *P*=not significant
Follow-up time >1 to <5 years								
Balshi SF, Wolfinger GJ, Balshi TJ (2007). Int J Oral Maxillofac Implants 22:467-471.	Up to 5 years	Immediate loading: Brånemark System Machined (n=3) Brånemark System TiUnite (n=12) Delayed loading: Brånemark System Machined (n=17) Brånemark System TiUnite (n=12)	Retrospective Comparative	Maxilla and mandible Implants without rotational primary stability Immediate (IL) vs delayed (DL) loading 1-stage/2-stage	39	IL: 15 DL: 29	TiUnite: 100 Machined: 66.7	TiUnite: 83.3 Machined: 70.6
den Hartog L, Raghoebar GM, Stellingsma K, Vissink A, Meijer HJ (2011). J Clin Periodontol 38:186-194.	18 months	NobelReplace Tapered	Prospective Randomized controlled	Maxilla anterior tooth Healed sites Immediate (IL) vs delayed (DL) loading Soft tissue health Osseointegration/bone preservation	IL: 31 DL: 31	IL: 31 DL: 31	96.8	100
Shibly O, Patel N, Albandar JM, Kutkut A (2010). J Periodontol 81:1743-1751. *Shibly O, Kutkut A, Patel N, Albandar JM (2012). Clin Implant Dent Relat Res 14:663-671.*	2 years 1 year	NobelReplace Straight	Prospective Comparative	Extraction sockets Periodontally compromised patients Immediate (IL) vs delayed (DL) loading Soft tissue health Osseointegration/bone preservation	IL: 30 DL: 30	IL: 30 DL: 30	96.7	93.3
Stephan G, Vidot F, Noharet R, Mariani P (2007). J Prosthet Dent 97:S138-S145.	2 years	Brånemark System Mk III TiUnite	Pilot study Comparative	Edentulous mandible Immediate (IL) vs delayed (DL) loading Soft tissue health Osseointegration/bone preservation	IL: 17 DL: 9	IL: 51 DL: 27	100	100
Follow-up time 1 year								
Alfadda SA (epub ahead 2013). Clinical Implant Dentistry and Related Research.	1 year	TiUnite implants	Prospective Blinded two-arm parallel Randomized controlled	Edentulous mandible Immediate (IL) vs delayed (DL) loading Osseointegration/bone preservation	IL: 16 DL: 22	IL: 72 DL: 88	95.8§	97.7§
De Rouck T, Collys K, Wyn I, Cosyn J (2009). Clin Oral Implants Res 20:566-570.	1 year	NobelReplace Tapered	Prospective Single-blind Randomized Comparative	Single tooth in extraction sites Immediate (IL) vs delayed (DL) loading Minimally invasive Soft tissue health Osseointegration/bone preservation Patient satisfaction	IL: 24 DL: 25	IL: 24 DL: 25	96	92

Reference	Follow-up time	Implant type	Study type	Indication/study focus	Number of patients*	Number of implants*	CSR %** Immediate loading	CSR %** Other loading protocol
Gothberg C, Andre U, Grondahl K, Ljungquist B, Thomsen P, Slotte C (epub ahead 2013). Clin Implant Dent Relat Res.	1 year	Brånemark System Mk III TiUnite	Prospective Randomized controlled Parallel-group	Partially edentulous Immediate (IL) vs delayed (DL) loading Osseointegration/bone preservation Soft tissue health	IL: 26 DL: 24	IL: 78 DL: 72	94.9	97.2
Güncü MB, Aslan Y, Tumer C, Guncu GN, Uysal S (2008). Clin Oral Implants Res 19:335-341.	1 year	Brånemark System Mk III TiUnite	Prospective Randomized controlled Comparative	Molar sites in mandible Minimally invasive Immediate (IL) vs delayed (DL) loading Osseointegration/bone preservation	12	IL: 12 DL: 12	91.7	100
Meloni SM, De Riu G, Pisano M, De Riu N, Tullio A (2012). Eur J Oral Implantol 5:345-353.	1 year	NobelReplace Tapered	Prospective Randomized controlled Split-mouth Comparative	Single mandibular molars Healed sites Immediate (IL) vs delayed (DL) loading Osseointegration/bone preservation	20	IL: 20 DL: 20	100	100
Schincaglia GP, Marzola R, Giovanni GF, Chiara CS, Scotti R (2008). Int J Oral Maxillofac Implants 23:474-480.	1 year	Brånemark System Mk III TiUnite	Prospective Randomized controlled Comparative	Single mandibular molars Immediate (IL) vs delayed (DL) loading Wide diameter implants Osseointegration/bone preservation	IL: 15 DL: 15	IL: 15 DL: 15	93.3	100
Vasak C, Kohal RJ, Lettner S, Rohner D, Zechner W (epub ahead 2012). Clin Oral Implants Res.	1 year	NobelReplace Tapered	Prospective Multicenter	All kind of indications Minimally invasive NobelGuide Immediate (IL) vs delayed (DL) loading Soft tissue health Osseointegration/bone preservation	IL: 17 DL: 13	IL: 98 DL: 65	100	96.9

Immediate Function versus early loading protocol

Reference	Follow-up time	Implant type	Study type	Indication/study focus	Number of patients*	Number of implants*	CSR %** Immediate loading	CSR %** Other loading protocol
Follow-up time >1 year								
Zembic A, Glauser R, Khraisat A, Hammerle CH (2010). Clin Oral Implants Res 21:481-489.	39.8 months (mean, range 36.7–53.1 months)	Brånemark System Mk IV	Prospective Randomized controlled	Free-end mandible Extraction and healed sites Immediate with occlusion (IL) vs early (EL) loading Osseointegration/bone preservation	11	IL: 22 EL: 22	85	100
Follow-up time 1 year								
Fischer K, Backstrom M, Sennerby L (2009). Clin Implant Dent Relat Res 11:69-80.	1 year	Replace Select	Prospective Comparative	Partially edentulous maxilla Immediate (single) vs early loading (bridge) Osseointegration/bone preservation	IL: 16 EL: 16	IL: 16 (single tooth) EL: 37 (multiple-unit bridge)	93.8	100

*Includes all eligible patients that received the TiUnite implant type(s) stated. Non-TiUnite implants are not reported in the table.

**If the CSR is not reported in the study, the percentage of surviving implants was calculated.

§ = per protocol analysis.

Overview of studies – Immediate Function with TiUnite versus machined surface implants.

The following overview groups clinical studies that compare Immediate Function with TiUnite versus machined surface implants according to follow-up time. Within each group the studies are listed alphabetically according to first author, and by publication date.

Only peer-reviewed clinical studies with at least 10 patients and at least 1 year of follow-up are listed. Abstracts, reviews, single case reports, technique descriptions, and animal and in vitro tests are excluded.

For more information on all studies on Immediate Function visit: nobelbiocare.com/scientific-evidence or PubMed at pubmed.gov

Reference	Follow-up time	Implant type	Study type	Indication/study focus	Number of patients*	Number of implants*	CSR %** TiUnite	CSR %** Machined
Follow-up time >6 years								
Bedrossian E (2010). Int J Oral Maxillofac Implants 25:1213-1221.	7 years (mean)	Brånemark System Mk IV TiUnite (n=54) NobelSpeedy (n=44) Zygoma Machined (n=74)	Prospective Single arm	Edentulous resorbed maxilla Immediate loading Minimally invasive Osseointegration/bone preservation	36	172	100	97.3
Miglioranca RM, Sotto-Maior BS, Senna PM, Francischone CE, Del Bel Cury AA (2012). Int J Oral Maxillofac Surg 41:1072-1076.	8 years	Zygoma implant Machined (n=40) NobelReplace Tapered (n=74)	Prospective Single arm	Extra-sinus placement Minimally invasive Immediate loading	21	114	95.6	97.5
Rocci A, Rocci M, Rocci C, Scoccia A, Gargari M, Martignoni M, Gottlow J, Sennerby L (2013). Int J Oral Maxillofac Implants 28:891-895. *Rocci A, Martignoni M, Gottlow J (2003). Clin Implant Dent Relat Res 5 Suppl 1:57-63.*	9 years 1 year	Brånemark System Mk III TiUnite (n=34) Brånemark System Mk IV TiUnite (n=32) Brånemark System Mk II Machined (n=7) Brånemark System Mk IV Machined (n=48)	Prospective Randomized controlled Comparative	Posterior mandible Partially edentulous Immediate loading Machined vs TiUnite implant surface Osseointegration/bone preservation	44	121	95.5	85.5
Follow-up time 3–6 years								
Aparicio C, Ouazzani W, Aparicio A, Fortes V, Muela R, Pascual A, Codesal M, Barluenga N, Manresa C, Franch M (2010). Clin Implant Dent Relat Res 12: 55-61.	41 months (mean, range 36–49 months)	TiUnite implants (n=104) Zygoma Machined (n=36)	Single-cohort	Edentulous maxilla Immediate loading Soft tissue health	20	140	100	100
Balshi TJ, Wolfinger GJ, Wulc D, Balshi SF (2011). J Prosthodont 20:10-15.	5.5 years	Brånemark System – Mk III TiUnite (n=30) – Mk IV TiUnite (n=64) – Ebon (n=5) – Mk II (n=1) – Standard (n=7) NobelPerfect (n=57)	Prospective Single arm	Single tooth implants Immediate loading	140	164	96.0	92.3
Balshi SF, Wolfinger GJ, Balshi TJ (2009). Int J Oral Maxillofac Implants 24:335-341.	0.8–5 years	Brånemark System Zygoma TiUnite (n=34) Zygoma Machined (n=76)	Retrospective Single arm	Maxillary atrophy Zygoma Immediate loading	56	110	100	94.7
Balshi SF, Wolfinger GJ, Balshi TJ (2007). Int J Oral Maxillofac Implants 22:467-471.	Up to 5 years	Immediate loading: Brånemark System TiUnite (n=12) Brånemark System Machined (n=3) Delayed loading: Brånemark System TiUnite (n=12) Brånemark System Machined (n=17)	Retrospective Comparative	Implants without rotational primary stability (RPS) Maxilla and mandible Immediate (IL) vs delayed (DL) loading 1-stage/2-stage	39	IL: 15 DL: 29	IL: 100 DL: 83.3	IL: 66.7 DL: 70.6

Reference	Follow-up time	Implant type	Study type	Indication/study focus	Number of patients*	Number of implants*	CSR %** TiUnite	CSR %** Machined
Balshi SF, Wolfinger GJ, Balshi TJ (2005). Clin Implant Dent Relat Res 7:24-31.	Up to 4 years	Immediate loading: Brånemark System Mk III TiUnite (n=147) Brånemark System Mk IV TiUnite (n=314) Brånemark System Ebon (n=19) Zygoma Machined (n=27) Brånemark System Machined (n=15) Delayed loading: Brånemark System Mk III TiUnite (n=6) Brånemark System Mk IV TiUnite (n=19) Zygoma Machined (n=1) Brånemark System Machined (n=4)	Prospective Single arm	Edentulous maxilla Minimally invasive Immediate (IL) vs delayed (DL) loading	55	552	IL: 99.3 DL: 88	IL: 96.7 DL: 100
Bedrossian E, Rangert B, Stumpel L, Indresano T (2006). Int J Oral Maxillofac Implants 21:937-942.	3 years (mean, up to 34 months)	Brånemark System Mk IV TiUnite (n=55) Zygoma Machined (n=28)	Retrospective Single arm	Edentulous maxilla Minimally invasive Immediate loading Osseointegration/bone preservation	14	83	100	100
Davo, R., C. Malevez, Pons O. (2013). Eur J Oral Implantol 6:39-47. *Davo R, Malevez C, Rojas J, Rodriguez J, Regolf J (2008). Eur J Oral Implantol 1:141-150.*	5 years 20.5 months (mean, range 12–42 months)	Brånemark System Zygoma TiUnite (n=37) Zygoma Machined (n=44) Brånemark System TiUnite and Replace Select (n=140)	Prospective	Fully and partially edentulous Atrophic maxilla Immediate loading	42	221	Zygoma: 100 Standard implants: 94.9	Zygoma: 97.7
Fung K, et al (2011). Int J Oral Maxillofac Implants 26:631-638.	3 years	Brånemark System Mk IV TiUnite (n=20) Brånemark System Mk IV Machined (n=22)	Prospective Split-mouth Randomized controlled	Partially edentulous mandible Posterior mandible Immediate loading Osseointegration/bone preservation	10	42	100	90.9
Hatano N, Yamaguchi M, Yaita T, Ishibashi T, Sennerby L (2011). Clin Oral Implants Res 22:1265-1269.	5 years (mean, range 1–10 years)	Brånemark System TiUnite (n=253) Brånemark System Machined (n=143)	Retrospective	Edentulous mandible Three implants per restoration Immediate loading	132	396	98.8	93
Liddelow G, Henry P (2010). Int J Prosthodont 23:13-21. *Liddelow GJ, Henry PJ (2007). J Prosthet Dent 97:S126-S137.*	3 years 1 year	Brånemark System Mk III TiUnite (n=25) Brånemark System Mk III Machined (n=7)	Prospective Comparative Randomized controlled	Edentulous Single implant-retained mandibular overdenture Immediate loading Osseointegration/bone preservation Patient satisfaction	32	32	100	57.1
Malo P, de Araujo Nobre M, Rangert B (2007). J Prosthet Dent 97:S86-S95.	5 years (retrospective) 1 year (prospective)	Brånemark System Mk II, Mk III and Mk IV NobelSpeedy (TiUnite: 268, Machined: 165)	Retrospective Prospective Comparative Historical control	Periodontally compromised Immediate loading Soft tissue health Osseointegration/bone preservation Standardized surgical and maintenance protocols	184	433	99.3	92.7
Östman PO, Hellman M, Sennerby L (2008). Int J Oral Maxillofac Implants 23:315-322.	Up to 4 years	Brånemark System Mk III TiUnite (n=157) Brånemark System Mk IV TiUnite (n=23) Brånemark System Standard Machined (n=3) Brånemark System Mk II Machined (n=6) Brånemark System Mk III Machined (n=55) Brånemark System Mk IV Machined (n=13)	Prospective Comparative	Partially edentulous mandible Immediate loading Osseointegration/bone preservation	77	257	99.4	96.1

*Includes all eligible patients that received the TiUnite implant type(s) stated. Non-TiUnite implants are not reported in the table.

**If the CSR is not reported in the study, the percentage of surviving implants was calculated.

Reference	Follow-up time	Implant type	Study type	Indication/study focus	Number of patients*	Number of implants*	CSR %** TiUnite	CSR %** Machined
Follow-up time < 3 years								
Calandriello R, Tomatis M (2004). Applied Osseointegration Research 4:32-40	1 year (mean, range 6-48 months)	Brånemark System Mk II, Mk III and Mk IV (TiUnite: 66, Machined: 32)	Prospective Comparative	Maxilla and mandible Single tooth Extraction and healed sites Immediate loading Osseointegration/bone preservation	74	98	100	96.9
Davo R, Malevez C, Rojas J (2007). J Prosthet Dent 97:S44-S51.	1.33 years (mean, range 6–29 months)	Brånemark System Mk IV TiUnite (n=68) Zygoma Machined (n=36)	Retrospective Single arm	Edentulous atrophic maxilla Immediate loading Osseointegration/bone preservation	18	104	95.6	100
Davo R, Pons O, Rojas J, Carpio E (2010). Eur J Oral Implantol 3:323-334.	1 year	Brånemark System Zygoma TiUnite (n=64) Zygoma Machined (n=4)	Prospective Single arm	Edentulous maxilla Minimally invasive Immediate loading	17	67	100	100
Fröberg KK, Lindh C, Ericsson I (2006). Clin Implant Dent Relat Res 8:187-197.	1.5 years	Brånemark System Mk III TiUnite (n=44) Brånemark System Mk III Machined (n=45)	Comparative	Edentulous mandible Immediate loading Procera Implant Bridge Soft tissue health Osseointegration/bone preservation	15	89	100	100
Östman PO, Hellman M, Sennerby L (2005). Clin Implant Dent Relat Res 7 Suppl 1:S60-S69.	1 year	Immediate loading: Brånemark System Mk III TiUnite (n=48) Brånemark System Mk IV TiUnite (n=42) Replace Select Tapered (n=33) Delayed loading (historical control): Brånemark System Mk III TiUnite (n=109) Brånemark System Mk IV Machined (n=11)	Prospective Historical control	Edentulous maxilla Immediate (IL) vs delayed (DL) loading Osseointegration/bone preservation	IL: 20 DL: 20	IL: 123 DL: 120	IL: 99.2 DL: 100	IL: n.a. DL: 100
Schincaglia GP, Marzola R, Scapoli C, Scotti R (2007). Int J Oral Maxillofac Implants 22:35-46.	1 year	Brånemark System Mk IV TiUnite (n=20) Brånemark System Mk IV Machined (n=22)	Prospective Randomized controlled Split-mouth Comparative	Posterior mandible Immediate loading Osseointegration/bone preservation	10	42	100	90.5

*Includes all eligible patients that received the TiUnite implant type(s) stated. Non-TiUnite implants are not reported in the table.

**If the CSR is not reported in the study, the percentage of surviving implants was calculated.

Proven concept with predictable outcomes.

Immediate implant placement in extraction sites is a proven concept with predictable outcomes for implants with TiUnite surface. As with every demanding protocol, careful patient selection is crucial to limit any potential increased risk of implant failure. Factors such as the type of extraction site, the presence of occlusal forces, and oral and overall patient health can all influence treatment success.

Accelerated healing with immediate implant placement

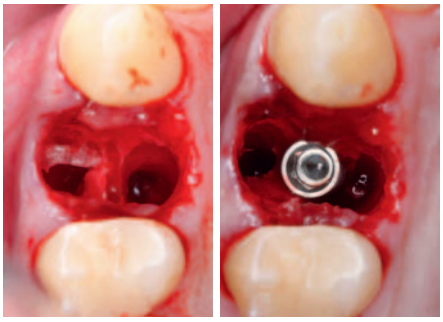
After tooth extraction, healing of the alveolus is characterized by connective tissue replacing granulation tissue in the first two weeks. Early osteoid appears at the periphery already after one week. After six weeks, bone trabeculae fill the socket more or less completely; and after four months, bone fill is complete. This healing sequence can be sped up by the installation of an implant, since the volume of the defect is substantially reduced and tissue ongrowth occurs directly on the implant surface.

Proven already with Brånemark System machined surface implants

Early results with machined surface Brånemark System implants showed that replacing teeth immediately with an implant is a valid treatment concept. Tolman and Keller (1991), for example, report up to 6-year follow-up on 61 patients.[1] They extracted 241 mandibular and 25 maxillary teeth, performed limited alveoloplasty and placed implants immediately in the extraction sites. At 6-year follow-up, only two of 301 implants had been lost, both in the maxilla of a single patient due to post-operative infection. Two years later, Gelb (1993) reports on 50 machined Brånemark System implants placed in 35 consecutive patients starting in 1989.[2] At follow-up in 1993, 49 implants (98%) were "osseointegrated and functional, supporting the predictability of immediate implant placement."

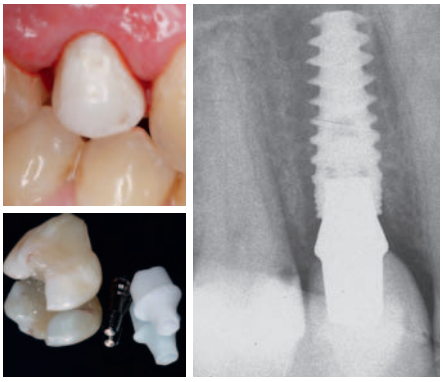
After 2000, experience and the available data quickly evolved – largely due to the introduction of the implant surface TiUnite but also due to further refinement of immediate placement and Immediate Function protocols.

1 Immediate implant placement in extraction site



Atraumatic extraction of maxillary birooted premolar and insertion of NobelActive implant. In this case, the bone void does not get filled with bone substitute.

2 Immediate Function with final abutment and temporary crown



Immediate temporization with final Procera Esthetic Abutment and temporary crown made from the extracted tooth.

Promising trends seen in meta-analyses

Reinforcing the limitations of meta-analysis, Quirynen et al. (2007) conclude that a meta-analysis could not be properly performed due to the heterogeneity of the available studies.[3] Atieh et al. (2009) report no statistically significant differences in their meta-analysis of studies on immediately loaded single-tooth implants in the esthetic zone in extraction versus healed sites.[4] Furthermore, Esposito et al. (2010) could not find any statistically significant differences in the Cochrane Review on immediate placement, stating that the available data is too limited to draw any final conclusions. They note, however, that immediate and immediate-delayed implants may be at a higher risk of failure and complications than delayed implants, but that esthetic outcomes may be better when placing implants right after tooth extraction.[5]

Although the available literature does not show any statistical difference between immediate and delayed implant placement, it is important to note that many studies reported in the published literature are run under ideal circumstances. Papers from private practices are therefore very relevant, as they indicate whether certain treatment modalities can also be handled successfully in routine practice. For example, Mura (2012) shows that implants immediately placed in extraction sites and immediately loaded with a provisional restoration can achieve a CSR of 100% after 5 years, and marginal bone remodeling of just -0.56 mm.[6]

Patient selection and clinical skills are crucial

Immediate implant placement has the potential to shorten healing times, reduce costs and decrease the number of required appointments, while also improving the esthetic outcome and increasing patient satisfaction. The faster improvement in quality of life can be a decisive argument, as patients do not want to have missing teeth during healing. However, since immediate implant placement is a more demanding protocol, the treatment outcome may be more heavily influenced by patient selection, the type of implants installed, the surgical protocol, as well as the clinician's experience.

3 Final result with excellent hard and soft tissue health

6-month follow-up. The final crown was placed 3 months after surgery.

Courtesy of Dr. Paul Weigl, Dr. Pablo Hess and ZA Eleftherios Grizas

Reliable long-term results.

Clinical studies with follow-up times of up to 10 years confirm the reliable performance of TiUnite implants with immediate implant placement in extraction sites. They include 1650 TiUnite implants in over 650 patients in various indications.

Key findings of the clinical studies are:
– Excellent long-term results with cumulative survival rates (CSR) between 96.5 and 100%.[7,6]
– No statistically significant differences in CSR in almost all studies on TiUnite implants in extraction versus healed sites (see table on page 44).
– Immediate placement can have a positive effect on marginal bone levels and esthetics.[4,5,8,9]
– Choice of treatment modality and implant type may be important for successful results: For example, the All-on-4 treatment concept[10] and NobelActive[8] implants show excellent results with regards to CSR, marginal bone levels, esthetics and quality of life.

High CSR in long-term studies

Degidi et al. (2012) report on 59 patients with 10-year follow-up.[7] 96 Brånemark Mk III TiUnite implants were immediately loaded in extraction sites and 114 in healed sites, with no significant difference in CSR (96.5% vs 98%) and marginal bone level change. Mura (2012) also reports a CSR of 100% after 5 years of follow-up.[6] 56 consecutive patients received 79 Replace Select Tapered implants following the Immediate Function protocol. Provisional restorations were delivered the same day and all had occlusal contact. Marginal bone levels were very stable, with a mean change of only -0.56 mm from implant insertion to 5-year follow-up.

Long-term studies on TiUnite implants placed immediately in extraction sites

Study	Follow-up	CSR
Degidi et al.2012[7]	10 years	96.5%
Mura 2012[6]	5 years	100%

Studies with follow-up times between 5 and 10 years show high cumulative survival rates (CSR) for immediate implant placement in extraction sites.

Comparative studies reveal little differences

Gillot et al. (2011) investigated whether there are any differences between implant placement in extraction and healed sites in full-arch restorations in the mandible.[11] They extracted on average 6.1 hopeless teeth from 105 consecutive patients and placed 4 to 6 Brånemark System Mk III and IV, NobelActive and NobelSpeedy implants. CSR values in fresh extraction and healed sites were both high at 4-month follow-up, with no statistically significant difference: 97.8% and 98.5% (P=0.4990). Although this follow-up is limited, it is sufficient to decide whether osseointegration has been successful.

A second retrospective study by the same group of authors looks at full-arch restorations in the maxilla.[12] It is the largest study comparing outcomes of immediate versus delayed placement of TiUnite implants in extraction sites. 113 consecutive patients were made edentulous by extracting 6.7 hopeless teeth on average. The majority received 6 implants (range 4–8), immediately loaded with a provisional full-arch restoration on the day of surgery. In total, 675 implants were placed (mainly NobelSpeedy and Brånemark System Mk IV). Gaps between the alveolar walls and the implants were filled with bone harvested during drilling. At 6-month follow-up, CSR was again high: 98.9% for extraction and 99.7% for healed sites (P=0.16; not significant). The authors postulate that these high CSR values may be related to the rigid splinting of the implants by a high-precision prosthetic approach, resulting in the high primary stability needed for successful bone apposition. They also conclude that implant survival is not influenced by the time of implant placement, neither in the edentulous maxilla nor the mandible.

The only comparative TiUnite study that shows a significant difference is on periodontally compromised patients.[13] All 12 patients presented with severe periodontitis and hopeless teeth and two thirds were smokers. After extraction, gaps between the alveolar walls and the implants were filled with bone harvested during drilling and a fixed provisional prosthesis was connected immediately after surgery. At 1-year follow-up, CSR was 92% in the maxilla and 100% in the mandible. The comparison between extraction and healed sites reveals dramatic differences: 87.5% versus 100%. This higher risk for implant failure in periodontally compromised maxillae clearly shows that a careful patient selection is crucial for a successful treatment outcome.

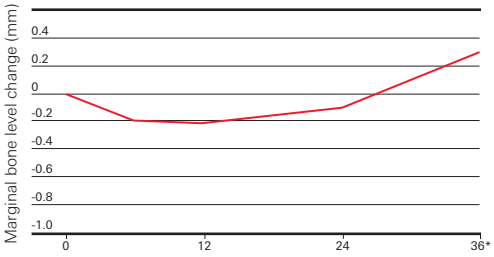
Choice of implants and treatment concepts is crucial in more demanding protocols.

Excellent results with immediate placement of NobelActive implants

Studies on NobelActive show excellent results, with respect to CSR as well as hard and soft tissue parameters. Cosyn et al. (2012), for example, report on the hard and soft tissue development in immediate single-tooth replacements in the esthetic zone.[9] 22 consecutive patients were treated by means of flapless extraction and implant surgery, immediate non-occlusal loading with a screw-retained provisional crown, and installation of a final crown after 6 months. In case of major alveolar process remodeling and/or advanced midfacial recession (>1 mm), a connective tissue graft was applied after 3 months. At 1-year follow-up, mean pink esthetic score (PES) was similar to preoperative status (12.15 vs. 11.86). The authors conclude that preservation of pink esthetics is possible with immediate implant placement in extraction sites in the esthetic area with NobelActive. A connective tissue graft was used in about one-third of the patients due to major alveolar process remodeling.

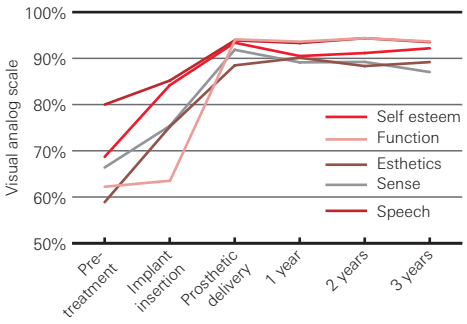
Kolinski et al. (2013) also report excellent results: high CSR, stable bone levels, good soft tissue health and patient satisfaction using NobelActive implants.[8] 60 implants were placed in 55 patients at 6 centers, all in extraction sites and subjected to Immediate Function. Patients requiring major bone augmentations were excluded, while minor augmentations were permitted. CSR after 3 years was 98.3%. Bone levels were exceptionally stable: Bone remodeling of a mere -0.2 mm during the first 6 months quickly stabilized and showed even a non-significant bone gain of 0.3 mm at 3 years. Papilla scores increased significantly (P<0.001) from insertion to 3-year follow-up, with most of the increase occurring during the first year. The results on quality of life are also noteworthy, with significant improvements in patient self-ratings on esthetics, self-esteem, function, sense and speech. The authors therefore conclude that NobelActive can be used safely and effectively under demanding conditions such as immediate tooth replacement in extraction sites – not only with regards to CSR and hard and soft tissue health, but also in terms of patient satisfaction.

Stable or increasing bone levels with NobelActive



Minimal marginal bone remodeling after implant insertion followed by stable or increasing bone levels – also in demanding protocols such as immediate loading in extraction sites.[8]

Immediate improvement of quality of life with NobelActive



Significant improvements in patient self-ratings of self-esteem, function, esthetics, sense and speech, right after implant insertion and at delivery of the final prosthesis.[8]

* Not significant.

The All-on-4 treatment concept is also suitable in extraction sites

Mozzati et al. (2013) show very successful outcomes using the All-on-4 treatment concept with immediate implant placement in extraction sites in the symphyseal area.[10] In their retrospective study on 200 implants with TiUnite surface (20 NobelSpeedy Groovy, 180 Brånemark System Mk III), they report a CSR of 100% at 2-year follow-up. All implants were successful both in extraction (n=121) and healed sites (n=79). In addition, patients reported high satisfaction with the immediately installed provisional fixed full-arch prosthesis in terms of eating comfort, esthetics, and speech. The final prosthesis was installed after 3 months.

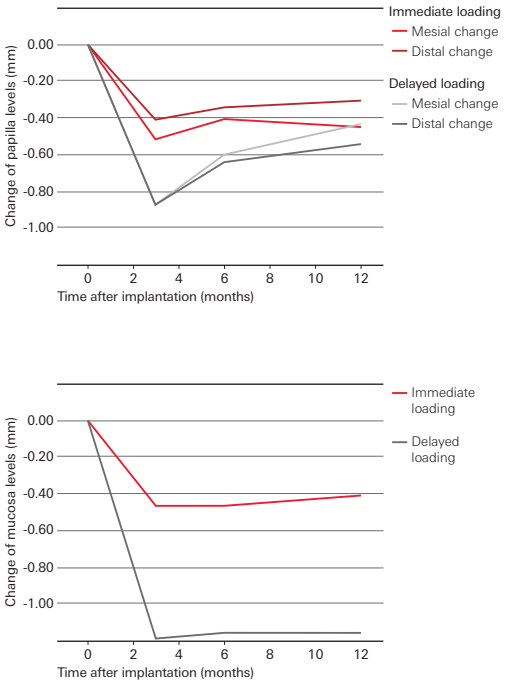
Excellent results with Immediate Function of immediately placed TiUnite implants

Improvements in survival rates of immediately loaded implants in fresh extraction sites parallel the increased adoption of implants with TiUnite surface by the clinical community. Krump and Barnett (1991) introduced immediate placement as a treatment option in the symphyseal area of the mandible using machined surface Brånemark System implants.[14] 3 of the 41 immediately loaded implants failed, which resulted in a CSR of 92.7%. This contrasted with the CSR of 98.1% in the control group of 154 implants placed in healed sites.

The available literature comparing the outcome of implants immediately placed in extraction sites by the loading protocol applied is limited. However, the studies that do exist show that immediate loading of immediately placed TiUnite implants reaches high survival rates. In the prospective study by Vanden Bogaerde et al. (2005), for example, 19 partially edentulous patients received 50 Brånemark System Mk IV TiUnite implants after tooth extraction in the maxilla (n=17) or the posterior mandible (n=5).[15] The implants were loaded with temporary prostheses either immediately on the day of surgery or early after 7 days. All patients were followed for 18 months, and none of the 50 implants failed.

In a prospective, randomized study by De Rouck et al. (2009), single NobelReplace Tapered implants were placed in fresh extraction sites in the anterior maxillae of 49 patients, following either an Immediate Function or conventional protocol.[16] The gaps between implants and bone were grafted with an anorganic bone substitute. After 1 year, 1 immediately loaded and 2 conventionally loaded implants had failed. Implant survival, bone remodeling, probing depth and bleeding tendency were not influenced by the restorative protocol. Esthetic results and papilla score, on the other hand, favored an Immediate Function approach. The authors therefore conclude that if primary implant stability permits, implants should be instantly provisionalized in the interest of optimal midfacial esthetics.

Better soft tissue levels with Immediate Function



Change in papilla and midfacial mucosa levels during the first year after implant placement, both for immediate and delayed loading. Immediate provisionalization limits midfacial soft tissue loss.[16]

Positive effects on hard and soft tissue health.

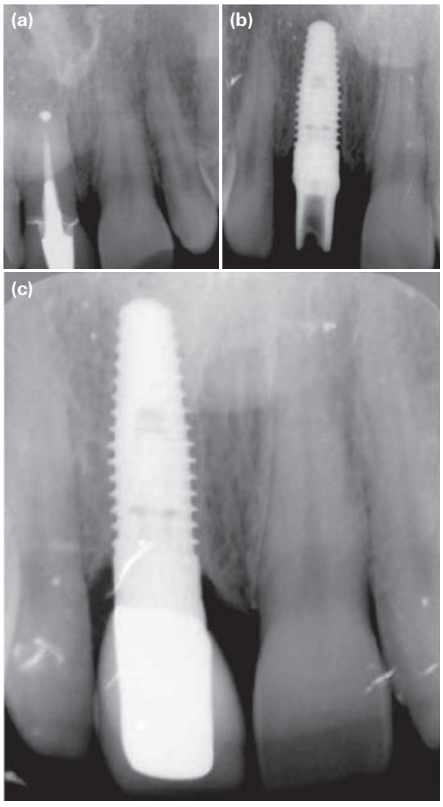
More findings apart from comparable CSR

There are very few papers that evaluate soft and hard tissue outcomes, and findings are mixed. Esposito et al. (2010) conclude in a Cochrane Review that "the aesthetic outcome might be better when placing implants just after tooth extraction."[5] In an earlier review by Chen et al. (2004), the authors conclude that early implant placement after extraction consistently results in reduced dehiscence defects.[17] Atieh et al. (2009) report that immediate implant placement may result in more stable bone levels.[4] However, all these meta-analyses tend to review, although systematically, very heterogeneous studies. Any result therefore needs to be interpreted with caution.

Stable marginal bone levels

In the long-term study by Degidi et al. (2012) with 10-year follow-up, marginal bone levels for immediately loaded implants in extraction and healed sites are statistically the same, with slightly less bone remodeling around immediately placed implants.[7] Hartlev et al. (2013) even report a significant bone gain of 0.5 mm from baseline to mean follow-up of 33 months (0.07–0.89 mm, P=0.022).[18] In their retrospective study, they immediately placed 68 Replace Select Tapered implants in the anterior maxillae of 68 patients. The final abutment and provisional crown were placed on the day of surgery and patients were instructed to avoid chewing and biting for 10 weeks. CSR was 98% at follow-up. In addition, no significant change in marginal bone levels at the neighboring teeth could be observed.

Stable bone levels
Case from Hartlev et al. (2013)[18]



a. Before tooth extraction
b. Just after immediate implant placement with a final titanium abutment and provisional crown
c. At 3-year follow-up with final metal-ceramic crown

Maintenance of soft tissue esthetics

In their series on 30 consecutive patients, Cosyn et al. (2011) look at the hard and soft tissue developments when immediately replacing single teeth in the esthetic zone with NobelReplace Tapered implants.[19] After 3 years, the CSR was 96% (25 patients could be re-evaluated). On average, radiographic examination showed -1.13 mm mesial and -0.86 mm distal bone level change. The esthetic outcome was objectively rated using the pink esthetic score (PES) and white esthetic score (WES). Mean mesial/distal papilla shrinkage and midfacial soft tissue recession in reference to the pre-operative status was 0.05, 0.08 and 0.34 mm, respectively. Between the 1- and 3-year follow-up, mesial papillae showed significant re-growth (0.36 mm; P=0.015). Advanced midfacial recession (>1 mm) was found in 2 patients. 5 patients suffered esthetic failures (PES<8 and/or WES<6), while 5 other patients showed an almost perfect outcome (PES≥12 and WES≥9). The remaining patients demonstrated acceptable esthetics.

The authors therefore concluded that the proposed strategy seems a "valuable and predictable treatment option for well-selected patients in the mid-long term as shown by almost full papillary re-growth and a low risk for advanced midfacial recession."[19]

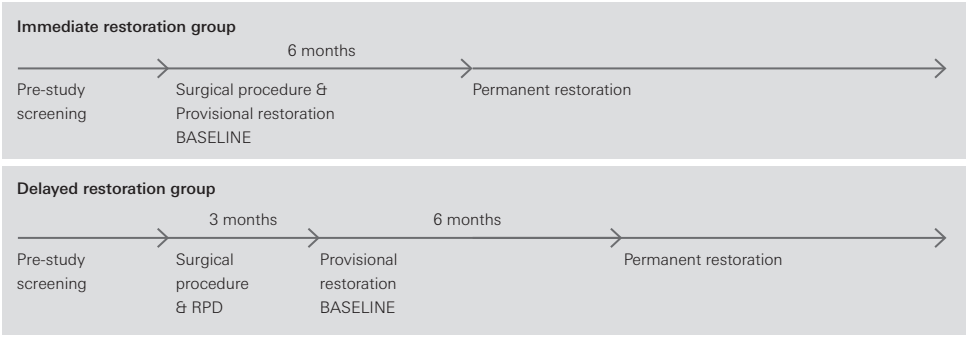
Natural-looking papillae and stable midfacial mucosa
Case from Cosyn et al. (2012)[9]

Dimensional changes of the soft tissue outline within the first year of implant placement:
a. Starting point with failing tooth 14 in situ
b. Soft tissue outline immediately after surgery with provisional restoration in place (non-occlusal loading)
c. Soft tissue outline after 3 months with some papilla loss at the mesial and distal aspect
d. Soft tissue outline after 12 months with regrown papillae and stable midfacial mucosa

Instant provisionalization of immediate single-tooth implants is essential to optimize esthetic treatment outcome

De Rouck T, Collys K, Wyn I, Cosyn J
Clin Oral Implants Res 2009;20:566-570

Treatment sequence for both treatment protocols



Marginal bone levels

Parameter	Treatment strategy	Month 3	Month 6	Month 12
Mesial (mm)	IRG	0.47 (0.29)	0.75 (0.44)§	0.92 (0.49)#
	DRG	0.61 (0.26)	0.89 (0.26)§	0.96 (0.25)#†
Distal (mm)	IRG	0.57 (0.65)	0.71 (0.73)§	0.79 (0.54)#
	DRG	0.53 (0.32)	0.87 (0.35)§*	0.97 (0.35)#†

Mean (SD)
§ Significant within group difference between 3 and 6 months.
# Significant within group difference between 3 and 12 months.
† Significant within group difference between 6 and 12 months.
* Significant between group difference.
IRG, immediate restoration group; DRG, delayed restoration group.

Decrease in marginal bone levels in relation to the time point of connecting the provisional restoration.

Papilla and midfacial mucosa levels

Parameter	Treatment strategy	Month 3	Month 6	Month 12
Mesial papilla (mm)	IRG	0.53 (0.84)	0.41 (0.83)	0.44 (0.77)
	DRG	0.87 (0.48)	0.60 (0.43)§	0.43 (0.42)#
Distal papilla (mm)	IRG	0.41 (0.80)	0.34 (0.81)	0.31 (0.81)
	DRG	0.87 (0.69)	0.63 (0.61)	0.53 (0.55)#
Midfacial mucosa (mm)	IRG	0.47 (0.78)	0.47 (0.72)	0.41 (0.75)
	DRG	1.19 (0.75)*	1.16 (0.64)*	1.16 (0.66)*

Mean (SD)
§ Significant within group difference between 3 and 6 months.
# Significant within group difference between 3 and 12 months.
* Significant between group difference.
IRG, immediate restoration group; DRG, delayed restoration group.

Loss in soft tissue dimensions in relation to the pre-operative status.

Original abstract

Objective: The immediate single-tooth implant has become a viable treatment option. However, the impact of the restorative procedure on esthetics is currently unclear. The goal of this study was to compare the soft tissue outline at immediate implants following two restorative protocols: immediate connection of a temporary crown or submerged healing during which a removable partial denture is used.

Materials and methods: A 1-year single-blind randomized clinical study was performed in 49 patients. Twenty-four patients were assigned to the immediate restoration group and 25 to the delayed restoration group. Clinical and radiographic evaluations of soft and hard tissues were carried out after 3, 6 and 12 months.

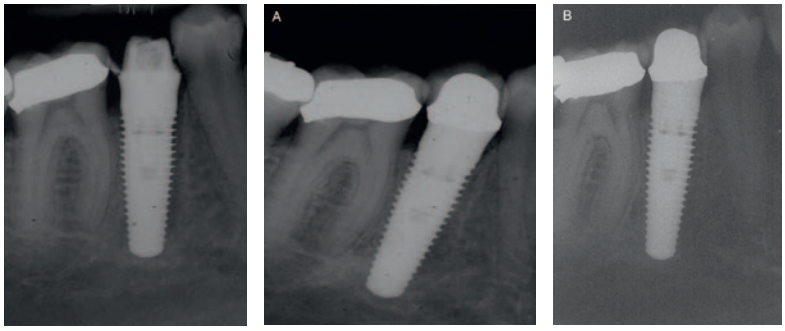
Results: Implant survival, bone remodeling, probing depth and bleeding tendency were not influenced by the restorative protocol. Delayed restoration resulted in initial papilla loss taking up to 1 year to attain comparable height as for immediate restoration. Midfacial recession was systematically 2.5-3 times higher following delayed restoration pointing to a 0.75 mm additional loss in comparison with immediate restoration after 1 year.

Conclusions: If the primary implant stability permits it, immediate single-tooth implants should be instantly provisionalized in the interest of optimal midfacial esthetics.

Immediate Loading of Tapered Implants Placed in Postextraction Sockets: Retrospective Analysis of the 5-Year Clinical Outcome

Mura P

Clin Implant Dent Relat Res 2012;14:565-574



Radiographs on day of surgery (extraction of 45, immediate implant insertion and provisionalization) and at 5- and 6-year follow-up.

Normal periimplant mucosa and no visible plaque at 5-year follow-up.

Marginal bone remodeling

	Implant Insertion to 3 Years		Implant Insertion to 4-Year Follow-Up		Implant Insertion to 5–6 Year Follow-Up	
Mean	–0.75		–0.48		–0.56	
SD	1.59		2.13		1.98	
n	41		42		63	
	n	%	*n*	%	*n*	%

Bone remodeling, presented as averages (mesial + distal)/2.

Original abstract

Introduction: The use of immediate implant loading protocols delivers obvious benefits to the patient. When applied in healed sites, this has not only been well documented in the totally edentulous mandible but has also been documented and reported to be predictable in the upper jaw, and in cases of partial edentulism, as well. A further application of immediate loading protocol, although still controversial, especially when replacing single maxillary teeth in the anterior zone, is the immediate implant placement and provisionalization in postextractive sockets. In consideration of the oxidized surface promoting bone healing and the tapered shape of the implant body, the Replace Select Tapered TiUnite implants have been used for many years in our clinic when facing these clinical situations. This article will report our long-term clinical experience with such implants and the relevant role of a correct surgical and prosthetic treatment planning.

Purpose: The aim of this retrospective study was to report on the 5-year clinical and radiologic outcome of patients treated with Replace Select Tapered TiUnite implants when used according to an immediate loading protocol in postextraction sites.

Method and materials: In routine practice, 56 consecutive patients were treated with 79 implants. The patients, 23 males and 33 females, had a mean age of 50.9 years, range 21–76 years, at implant placement. Forty-seven implants were placed in the maxilla and 32 implants were placed in the mandible. All implants were placed in postextraction sites and were immediately loaded. Provisional restorations were delivered within 2 hours from surgery and all were in occlusion. Forty-three patients received a single implant while in the remaining 13 patients the implants were splinted.Definitive prosthetic restoration was delivered within 1 to 4 months following implant placement. Evaluations of soft tissue health and marginal bone remodeling were conducted. An independent radiologist performed the radiographic evaluation using the top of the implant as the reference point with negative values indicating a level below the reference point.

Results: Forty-eight patients, accounting for 66 implants, have passed the 5-year follow-up. No implants have failed resulting in a 5-year cumulative implant survival rate of 100%. Three patients, with six implants, withdrew during the course of the follow-up; one patient passed away and two patients moved. Five patients with seven implants did not show up at 5 years recall. At the 5-year follow-up, majority of the implants that were followed demonstrated normal periimplant mucosa and no visible plaque. The mean bone level at 5-year follow-up was -2.45 mm (SD 1.29, n = 63) demonstrating a level in line with the first thread. Mean marginal bone loss from implant insertion to 5 years was 0.56 mm(SD 1.98, n = 63). Regarding complications, a fracture of the ceramic crown was reported 5 years after implant insertion in a patient who developed bruxism. No other biologic nor mechanical complications were reported.

Conclusion: This retrospective 5-year follow-up study of 56 patients treated with implants immediately placed in postextraction sockets and immediately loaded demonstrates good treatment outcome with regard to implant survival, soft tissue condition, and marginal bone response.

References.

1 Tolman DE, Keller EE. Endosseous implant placement immediately following dental extraction and alveoloplasty: preliminary report with 6-year follow-up. Int J Oral Maxillofac Implants 1991;6:24-28

2 Gelb DA. Immediate implant surgery: three-year retrospective evaluation of 50 consecutive cases. Int J Oral Maxillofac Implants. 1993;8:388-399

3 Quirynen M, Van Assche N, Botticelli D, Berglundh T. How does the timing of implant placement to extraction affect outcome? Int J Oral Maxillofac Implants 2007;22 Suppl:203-223

4 Atieh MA, Payne AG, Duncan WJ, Cullinan MP. Immediate restoration/loading of immediately placed single implants: is it an effective bimodal approach? Clin Oral Implants Res 2009;20:645-659

5 Esposito MA, Grusovin MG, Polyzos IP, Felice P, Worthington HV. Timing of implant placement after tooth extraction: immediate, immediate-delayed or delayed implants? A Cochrane systematic review. Eur J Oral Implantol. 2010;3:189-205

6 Mura P. Immediate Loading of Tapered Implants Placed in Postextraction Sockets: Retrospective Analysis of the 5-Year Clinical Outcome. Clin Implant Dent Relat Res 2012;14:565-574

7 Degidi M, Nardi D, Piattelli A. 10-Year Follow-Up of Immediately Loaded Implants with TiUnite Porous Anodized Surface. Clin Implant Dent Relat Res 2012;14:828-838

8 Kolinski ML, Cherry JE, McAllister BS, Parrish KD, Pumphrey DW, Schroering RL. Evaluation of a Variable-Thread Tapered Implant in Extraction Sites With Immediate Temporization: A 3-Year Multi-Center Clinical Study. J Periodontol 2013 [Epub ahead of print]

9 Cosyn J, De Bruyn H, Cleymaet R. Soft Tissue Preservation and Pink Aesthetics around Single Immediate Implant Restorations: A 1-Year Prospective Study. Clin Implant Dent Relat Res 2012 [Epub ahead of print]

10 Mozzati M, Arata V, Gallesio G, Mussano F, Carossa S. Immediate Postextractive Dental Implant Placement with Immediate Loading on Four Implants for Mandibular-Full-Arch Rehabilitation: A Retrospective Analysis. Clin Implant Dent Relat Res 2013;15:332-340

11 Gillot L, Noharet R, Buti J, Cannas B. A retrospective cohort study of 105 patients rehabilitated with immediately loaded mandibular cross-arch bridges in combination with immediate implant placement. Eur J Oral Implantol 2011;4:247-253

12 Gillot L, Cannas B, Buti J, Noharet R. A retrospective cohort study of 113 patients rehabilitated with immediately loaded maxillary cross-arch fixed dental prostheses in combination with immediate implant placement. Eur J Oral Implantol 2012;5:71-79

13 Deng F, Zhang H, Shao H, He Q, Zhang P. A comparison of clinical outcomes for implants placed in fresh extraction sockets versus healed sites in periodontally compromised patients: a 1-year follow-up report. Int J Oral Maxillofac Implants 2010;25:1036-1040

14 Krump JL, Barnett BG. The immediate implant: a treatment alternative. Int J Oral Maxillofac Implants 1991;6:19-23

15 Vanden Bogaerde L, Rangert B, Wendelhag I. Immediate/early function of Brånemark System TiUnite implants in fresh extraction sockets in maxillae and posterior mandibles: an 18-month prospective clinical study. Clin Implant Dent Relat Res 2005;7 Suppl 1:121-130

16 De Rouck T, Collys K, Wyn I, Cosyn J. Instant provisionalization of immediate single-tooth implants is essential to optimize esthetic treatment outcome. Clin Oral Implants Res 2009;20:566-570

17 Chen ST, Wilson TG, Jr., Hämmerle CH. Immediate or early placement of implants following tooth extraction: review of biologic basis, clinical procedures, and outcomes. Int J Oral Maxillofac Implants 2004;19 Suppl:12-25

18 Hartlev J, Kohberg P, Ahlmann S, Gotfredsen E, Andersen NT, Isidor F, Schou S. Immediate placement and provisionalization of single-tooth implants involving a definitive individual abutment: a clinical and radiographic retrospective study. Clin Oral Implants Res 2013;24:652-658

19 Cosyn J, Eghbali A, De Bruyn H, Collys K, Cleymaet R, De Rouck T. Immediate single-tooth implants in the anterior maxilla: 3-year results of a case series on hard and soft tissue response and aesthetics. Clin Periodontol. 2011;38(8):746-753

Overview of studies – TiUnite implants in extraction sites.

The following overview groups clinical studies on TiUnite implants placed in extraction sites according to follow-up time. Within each group, the studies are listed alphabetically according to first author, and by publication date. Studies with comparative data are listed in separate tables: extraction versus healed sites see page 44; immediate loading versus other loading protocols see page 46.

Only peer reviewed clinical studies with at least 10 patients and at least 1 year of follow-up are listed. Abstracts, reviews, single case reports, technique descriptions, and animal and in vitro tests are excluded.

For more information on all studies on immediate implant placement in extraction sites visit: nobelbiocare.com/scientific-evidence or PubMed at pubmed.gov

Reference	Follow-up time	TiUnite implant	Study type	Indication/study focus	Number of patients*	Number of implants*	CSR %**
Follow-up time 3–5 years							
Cosyn J, Eghbali A, De Bruyn H, Collys K, Cleymaet R, De Rouck T (2011). J Clin Periodontol 38:746-753.	3 years	NobelReplace	Prospective	Single tooth in anterior maxilla Minimally invasive Immediate loading Soft tissue health Osseointegration/bone preservation	30	30	96
Hartlev J, Kohberg P, Ahlmann S, Gotfredsen E, Andersen NT, Isidor F, Schou S (2013). Clin Oral Implants Res 24:652-658.	33 months	Replace Select Tapered	Retrospective Monocenter	Single crowns Minimally invasive Immediate loading Soft tissue health Osseointegration/bone preservation	55	55	98
Kolinski ML, Cherry JE, McAllister BS, Parrish KD, Pumphrey DW, Schroering RL.(epub ahead 2013) J Periodontol. *McAllister BS, Cherry JE, Kolinski ML, Parrish KD, Pumphrey DW, Schroering RL (2012). Int J Oral Maxillofac Implants 27: 611-618.*	3 years 2 years	NobelActive	Prospective Multicenter Single arm	Partially edentulous Minimally invasive Immediate loading Soft tissue health Osseointegration/bone preservation	55	60	98.3
Mura P (2012). Clin Implant Dent Relat Res 14:565-574.	5 years	Replace Select Tapered	Retrospective Monocenter	Extraction sites Minimally invasive Immediate loading Osseointegration/bone preservation	56	79	100
Follow-up time <3 years mean							
Cosyn J, De Bruyn H, Cleymaet R (epub ahead 2012). Clin Implant Dent Relat Res.	1 year	NobelActive	Prospective	Single implants Immediate loading Soft tissue health Osseointegration/bone preservation	22	22	95.5
De Rouck T, Collys K, Cosyn J (2008). J Clin Periodontol 35:649-657.	1 year	NobelReplace Tapered	Prospective	Single tooth Minimally invasive Immediate loading Soft tissue health Osseointegration/bone preservation	30	30	97
Kan JY, Rungcharassaeng K, Morimoto T, Lozada J (2009). J Oral Maxillofac Surg 67:40-48.	1–4 years	NobelReplace Tapered NobelPerfect	Case study Monocenter	Immediate loading Soft tissue health Osseointegration/bone preservation	20	20	100
Kan JY, Rungcharassaeng K, Sclar A, Lozada JL (2007). J Oral Maxillofac Surg 65:13-19.	1 year	Replace Select NobelPerfect	Monocenter	Single tooth Immediate loading Soft tissue health Osseointegration/bone preservation	23	23	100
Noelken R, Kunkel M, Wagner W (2011). Int J Periodontics Restorative Dent 31:175-183.	13–36 months	NobelPerfect	Monocenter	Minimally invasive Immediate loading Osseointegration/bone preservation Soft tissue health	16	18	100

Reference	Follow-up time	TiUnite implant	Study type	Indication/study focus	Number of patients*	Number of implants*	CSR %**
Urban T, Kostopoulos L, Wenzel A (2012). Clin Oral Implants Res 23:1389–1397.	1 year	Brånemark System Mk III Groovy	Prospective Randomized controlled	Molar region Bone reconstruction Minimally invasive Delayed loading Soft tissue health	92	92	82.6
Vanden Bogaerde L, Rangert B, Wendelhag I (2005). Clin Implant Dent Relat Res 7 Suppl 1:S121-130.	18 months	Brånemark System Mk IV	Prospective	Partial maxilla and posterior mandible Minimally invasive Immediate or early loading Osseointegration/bone preservation	19	50	100
Villa R, Rangert B (2007). J Prosthet Dent 97:S96-S108.	1 year	Brånemark System Mk III and Mk IV NobelSpeedy	Prospective Pilot study	Maxilla Extraction sockets of infected teeth Minimally invasive Immediate or early loading Osseointegration/bone preservation	33	76	97.4

*Includes all eligible patients that received the TiUnite implant type(s) stated. Non-TiUnite implants are not reported in the table.

**If the CSR is not reported in the study, the percentage of surviving implants was calculated.

Overview of studies – TiUnite implants in extraction versus healed sites.

The following overview groups clinical studies comparing immediate implant placement in extraction and healed sites according to follow-up time. Within each group, the studies are listed alphabetically according to first author, and by publication date.

Only peer reviewed clinical studies with at least 10 patients are listed. Abstracts, reviews, single case reports, technique descriptions, and animal and in vitro tests are excluded.

For more information on all studies on immediate implant placement in extraction sites visit: nobelbiocare.com/scientific-evidence or PubMed at pubmed.gov

Reference	Follow-up time	TiUnite implant	Study type	Indication/study focus	Number of patients*	Number of implants*	CSR %** Extraction sites (ES)	CSR %** Healed sites (HS)
Follow-up time 10 years								
Degidi M, Nardi D, Piattelli A (2012). Clin Implant Dent Relat Res 14:828-838.	10 years	Brånemark System Mk III	Prospective	Minimally invasive Immediate loading Osseointegration/bone preservation	59	ES: 74 HS: 84	96.5	98.0
Follow-up time > 1 years								
Agliardi EL, Francetti L, Romeo D, Del Fabbro M (2009). Int J Oral Maxillofac Implants 24:887-895.	18–42 months	Brånemark System Mk IV NobelSpeedy Groovy	Prospective	Edentulous maxilla Immediate loading Axial and tilted implants Osseointegration	20	ES: 40 HS: 80	100	100
Cosyn J, Eghbali A, Hanselaer L, De Rouck T, Wyn I, Sabzevar MM, Cleymaet R, De Bruyn H (epub ahead 2012). Clin Implant Dent Relat Res.	30 months (mean, range 17–44 months)	Replace Select	Retrospective Comparative	Anterior maxilla Immediate vs delayed loading Soft tissue health Osseointegration/bone preservation Patient satisfaction	74 ES: 30 HS: 44	ES: 30 HS: 49	92.9	93.0
Malo P, Nobre Mde A, Lopes A (2012). Int J Oral Maxillofac Implants 27:1177-1190.	26 months (mean, range 1–107 months)	Brånemark System Mk III Brånemark System MK IV NobelActive NobelSpeedy	Prospective	Edentulous All-on-4 treatment concept Immediate loading Osseointegration/bone preservation	142	ES: 18 HS: 209	94.4	97.4
Mozzati M, Arata V, Gallesio G, Mussano F, Carossa S (epub ahead 2012). Clin Implant Dent Relat Res.	2 years	Brånemark System Mk III NobelSpeedy Groovy	Retrospective Monocenter	Edentulous mandible All-on-4 treatment concept Minimally invasive Immediate loading Osseointegration/bone preservation	50	ES: 121 HS: 79	100	100
Rompen E, Raepsaet N, Domken O, Touati B, Van Dooren E (2007). J Prosthet Dent 97:S119-S125.	19.1 months (mean, range 12–24 months)	Replace Select TiUnite (prototype)	Pilot study	Maxilla and mandible Predominantly single tooth Immediate loading Soft tissue health	40	ES: 25 HS: 29	100	100
Siepenkothen T (2007). J Prosthet Dent 97:S69-78.	17 months (mean)	NobelDirect	Retrospective Monocenter	Maxilla and mandible Single tooth and partially edentulous Immediate loading Osseointegration/bone preservation	58	ES: 10 HS: 82	100	100
Weinstein R, Agliardi E, Fabbro MD, Romeo D, Francetti L (epub ahead). Clin Implant Dent Relat Res 14:434-441.	30.1 months (mean, range 20–48 months)	Brånemark System Mk IV NobelSpeedy Groovy	Prospective	Extremely atrophic edentulous mandible All-on-4 treatment concept Minimally invasive Immediate loading Soft tissue health Osseointegration/bone preservation	20 ES: 7 HS: 13	ES: 13 HS: 67	100	100
Follow-up time up to 1 year								
Deng F, Zhang H, Shao H, He Q, Zhang P (2010). Int J Oral Maxillofac Implants 25:1036-1040.	1 year	Brånemark System Mk III TiUnite NobelSpeedy	Prospective Comparative non-randomized	Edentulous jaws Periodontally compromised Minimally invasive Immediate loading	12	ES: 32 HS: 52	87.5	100 *P*=0.039

Reference	Follow-up time	TiUnite implant	Study type	Indication/study focus	Number of patients*	Number of implants*	CSR %** Extraction sites (ES)	CSR %** Healed sites (HS)
Gillot L, Cannas B, Buti J, Noharet R (2012). Eur J Oral Implantol 5:71-79.	6 months	Brånemark System Mk III Brånemark System Mk IV NobelActive NobelSpeedy	Retrospective Single cohort	Edentulous maxilla Minimally invasive Immediate loading Osseointegration/bone preservation	113	ES: 352 HS: 323	98.6	99.7 *P*=0.1621 (not significant)
Gillot L, Noharet R, Buti J, Cannas B (2011). Eur J Oral Implantol 4:247-253.	4 months	Brånemark System MK III NobelSpeedy	Retrospective	Edentulous mandible Minimally invasive Immediate loading	105	ES: 182 HS: 266	97.8	98.5 *P*=0.4990 (not significant)
Kan JY, Rungcharassaeng K, Liddelow G, Henry P, Goodacre CJ (2007). J Prosthet Dent 97:S109-S118.	1 year	NobelPerfect	Monocenter	Single tooth Immediate loading Soft tissue health Osseointegration/bone preservation	29	ES: 23 HS: 15	100	100
Sennerby L, Rocci A, Becker W, Jonsson L, Johansson LA, Albrektsson T (2008). Clin Oral Implants Res 19:219-226.	1–18 months	NobelDirect	Retrospective Multicenter	Maxilla and mandible All types of loading Osseointegration	43	ES: 18 HS: 99	94.4	94.9

Reported p-values are for significance of differences in CSR of extraction vs. healed sites.

*Includes all eligible patients that received the TiUnite implant type(s) stated. Non-TiUnite implants are not reported in the table.

**If the CSR is not reported in the study, the percentage of surviving implants was calculated.

Overview of studies – TiUnite implants in extraction sites with Immediate Function versus other loading protocols.

The following overview groups clinical studies comparing immediate implant placement in extraction sites comparing Immediate Function with other loading protocols.

Only peer reviewed clinical studies with at least 10 patients and at least 1 year of follow-up are listed. Abstracts, reviews, single case reports, technique descriptions, and animal and in vitro tests are excluded.

For more information on all studies on immediate implant placement in extraction sites visit: nobelbiocare.com/scientific-evidence or PubMed at pubmed.gov

Reference	Follow-up time	TiUnite implant	Study type	Indication/study focus	Number of patients*	Number of implants*	CSR %** Immediate Function	CSR %** Delayed loading
Shibly O, Kutkut A, Patel N, Albandar JM (2012). Clin Implant Dent Relat Res 14:663-671. *Shibly O, Patel N, Albandar JM, Kutkut A (2010). J Periodontol 81:1743-1751.*	2 years 1 year	NobelReplace Straight	Prospective Randomized controlled	Extraction sites Immediate (IL) vs delayed (DL) loading Soft tissue health Osseointegration/bone preservation	IL: 30 DL: 30	IL: 30 DL: 30	96	93 *P*=not significant
De Rouck T, Collys K, Wyn I, Cosyn J (2009). Clin Oral Implants Res 20:566-570.	1 year	NobelReplace Tapered	Prospective Singe-blind Randomized Comparative	Single tooth in extraction sites Immediate (IL) vs delayed (DL) loading Minimally invasive Soft tissue health Osseointegration/bone preservation	IL: 24 DL: 25	IL: 24 DL: 25	96	92 *P*=not reported

Reported p-value reports significance of CSR of delayed vs. immediately loaded implants, immediately placed in extraction sites.
*Includes all eligible patients that received the TiUnite implant type(s) stated. Non-TiUnite implants are not reported in the table.
**If the CSR is not reported in the study, the percentage of surviving implants was calculated.

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